POWER

Volume 59 New York, May 27, 1924 *No.* 22

The Chronic Grouch

I MET him in the smoking end of a sleeper. He had a slightly foreign accent and the world was not run to suit him.

The weather was execrable. He had been south to keep warm and had never got rid of his winter flannels. He seemed to feel as though he had a personal account against the Sunny South for failure to realize his expectations.

The service in the dining car was "rotten." I had not noticed but that it was up to the average, and at the usual prices, but he assured me that the food was illy kept, and poorly cooked, the waiters lazy and insolent, the coffee a sloppy souvenir of a church sociable, and the prices outrageous.

The railroad itself was "on the blink." The rolling stock was so old that it creaked, his berth was as hard as Pharaoh's heart, the road bed was so rough that he was seasick, and the "freight handler" they had for an engineer yanked the train so in starting that it nearly chucked him through the partition.

The Government at Washington was a sorry mess. The President was a clam who did not say anything because he did not know what to say, and the Senators and others said too much because they did not know any better. I could not get a word of admiration, commendation or approval for any man or any measure except that to repeal the prohibition law.

I do not know whether he thought he could run things any better or not. He did not offer any constructive suggestions.

I wondered if in his early reading he had escaped the story in the German primer of the two little girls in the rose garden.

One said "See all those ugly thorns. Is it not a shame that they are here to spoil these beautiful roses?"

The other said, "Is it not nice that these beautiful roses are here to cover up the thorns?"

F. R. Low

Trenton Channel Plant of the Detroit-Edison Co.

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Technical Engineer of Power Plants

FIRST half of six-unit 300,000-kw. ultimate-plant. Three boilers per turbine, burning powdered coal, with ventilated furnace walls to preheat the air, steam-heated driers for the coal and electrostatic precipitation to remove fine ash from flue gases. Operating pressure 415 lb. gage and steam temperature 700 deg. F. Steam bled from three stages of main units. Economizers employed and evaporators for 1½ per cent makeup. House turbines supplying both alternating and direct current are entirely independent of the variable-voltage main power system.

IN STUDYING the design of a central station, it is important to bear in mind its place in the system that it is to serve, since the design must often be adapted to meet conditions in no way involving the interior economy of the station considered by itself. The Trenton Channel plant of the Detroit Edison Company is some eighteen miles south from the center of Detroit, on the Detroit River, and will deliver its output solely through a 120,000-volt transmission system which feeds the distribution network through a small number of switching and transformer stations. This high-voltage transmission line, made up of two circuits, runs around the periphery of the load area, terminating at the north in the Marysville plant, 55 miles north of Detroit, and hence about 75 miles from Trenton Channel.

Since Trenton Channel will be a strictly transmission-line station, it is planned to regulate the main bus voltage at the station so as to maintain the desired voltage at one or another of the remote switching points. In consequence of this the voltage on the station bus will vary with the loading of the tranmission line, over a range of perhaps 15 per cent between maximum and minimum on the station bus. For this reason it was decided early that there should be no connection whatever between the main and auxiliary power systems within the station, and this decision has naturally had a far-reaching influence on the auxiliary power layout.

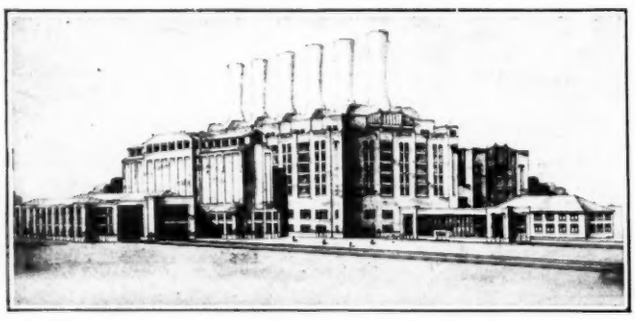
The Trenton Channel site is exceptionally favorable. Bedrock is just far enough beneath the surface so that the condensing-water canals can be constructed without cutting rock. With the rock so close to the surface there has been no foundation problem, since it has been easy to run concrete column footings direct to rock. Railroad facilities are good, the site being served by two railroads. The Detroit River furnishes an ample supply of excellent condensing water, and the fact that the plant is on an island, separated from the mainland by a narrow canal, has made it possible so to arrange the intake canals that accidental recirculation of the water is virtually eliminated.

Briefly, the plant is operated on the regenerative cycle, heating the feed water by steam bled from the main units and feeding through economizers to Stirling W-type boilers. Evaporators for makeup water are a part of the main turbine steam-extraction system. Coal is burned in the pulverized form, the flue gas being handled by induced-draft fans discharging through short stacks. Dust-removing equipment in the breeching is designed to obviate any possible nuisance from the discharge of dust. Auxiliary power is furnished by steam-turbine-driven direct-current generators, by steam turbo-alternators and by a connection from the nearest substation of the company, similar to that which would be made for any large customer. The house turbines, both direct- and alternating-current, are bled for building heating. Coal is received by rail, and ash is sluiced out into a basin to be used for fill for several years at least. The main electrical gear is almost all out of doors, including a duplicate outdoor bus at 120,000 volts.

Ultimate capacity for which the plant is designed is 300,000 kw., to be furnished by six units of 50,000 kw. each, with three boilers per unit. The present installation will be just one-half of the ultimate plant, including three main units with auxiliaries, eight boilers with coal-preparation machinery, etc., cooling-water tunnels, and the like. This description covers only the present installation.

The main turbines are 21-stage impulse machines with provision for extracting steam from the fourteenth, seventeenth and nineteenth stages. They are designed to operate with a steam pressure of 375 lb. per sq.in. gage at the throttle, an initial steam temperature of 700 deg. F. and at a speed of 1,200 r.p.m. With an exhaust pressure of one inch of mercury absolute, they are expected to deliver 1 kw.-hr. for 9.4 lb. of steam (with no steam extraction) at their best load, which is about 42,500 kw. The generators are of 62,500 kva. capacity, with direct-connected exciters.

Steam enters the turbine through a nozzle that is vertically below the shaft center line. This location eliminates lateral movement of the nozzle owing to turbine casing expansion, and therefore simplifies the sufficiently difficult problem of designing the main steam piping to eliminate undesirable forces acting on this nozzle. The overload steam connection, which admits steam into the fifth-stage shell, is unusual in that it is con-



Architect's sketch of completed station

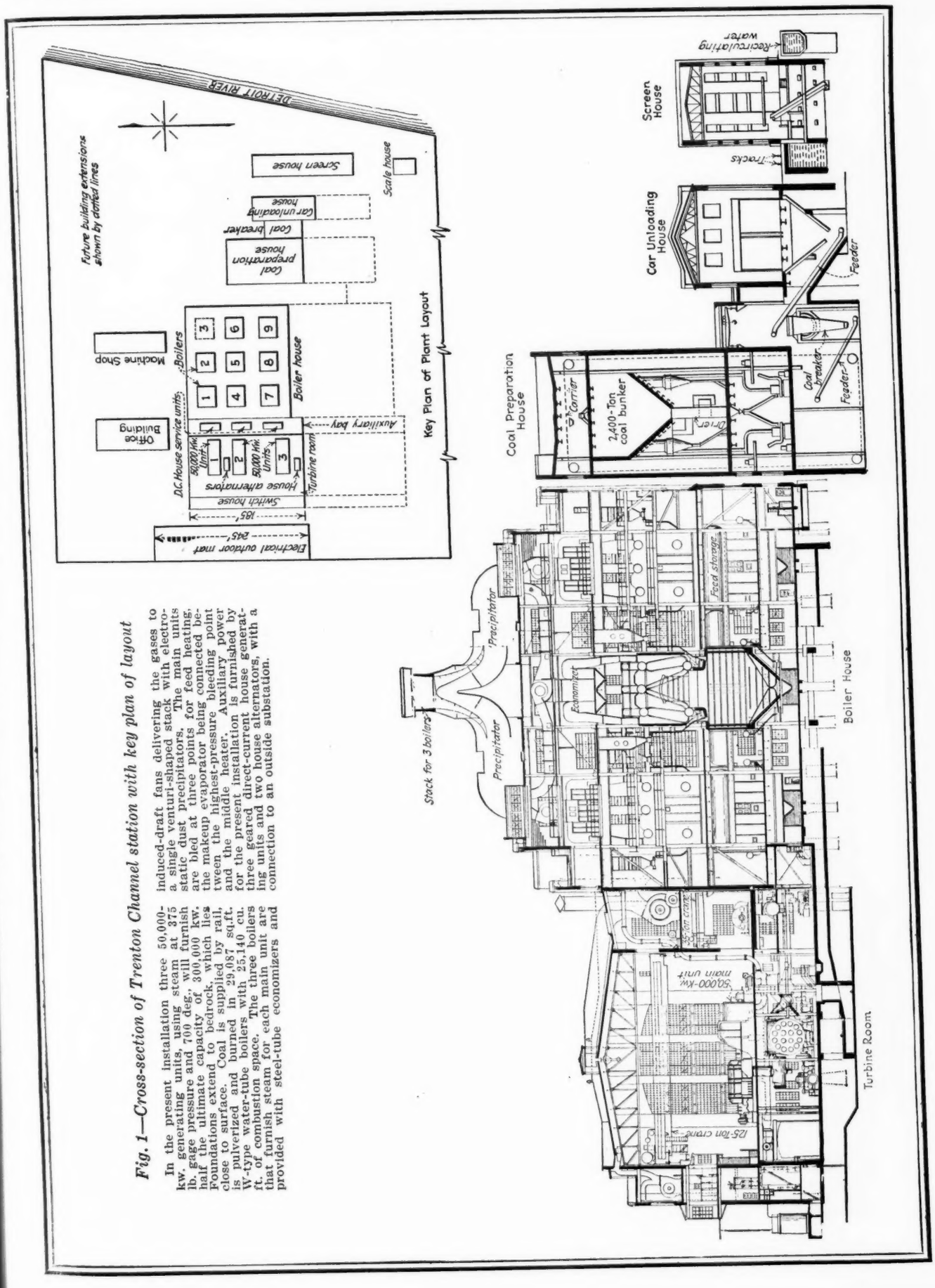


Fig. 1—Cross-section of Trenton Channel station with key plan of layout

In the present installation three 50,000-kw. generating units, using steam at 375 lb. gage pressure and 700 deg., will furnish half the ultimate capacity of 300,000 kw. Foundations extend to bedrock, which lies close to surface. Coal is supplied by rail, is pulverized and burned in 29,087 sq.ft. W-type water-tube boilers with 25,140 cu. ft. of combustion space. The three boilers that furnish steam for each main unit are provided with steel-tube economizers and induced-draft fans delivering the gases to a single venturi-shaped stack with electrostatic dust precipitators. The main units are bled at three points for feed heating, the makeup evaporator being connected between the highest-pressure bleeding point and the middle heater. Auxiliary power for the present installation is furnished by three geared direct-current house generating units and two house alternators, with a connection to an outside substation.

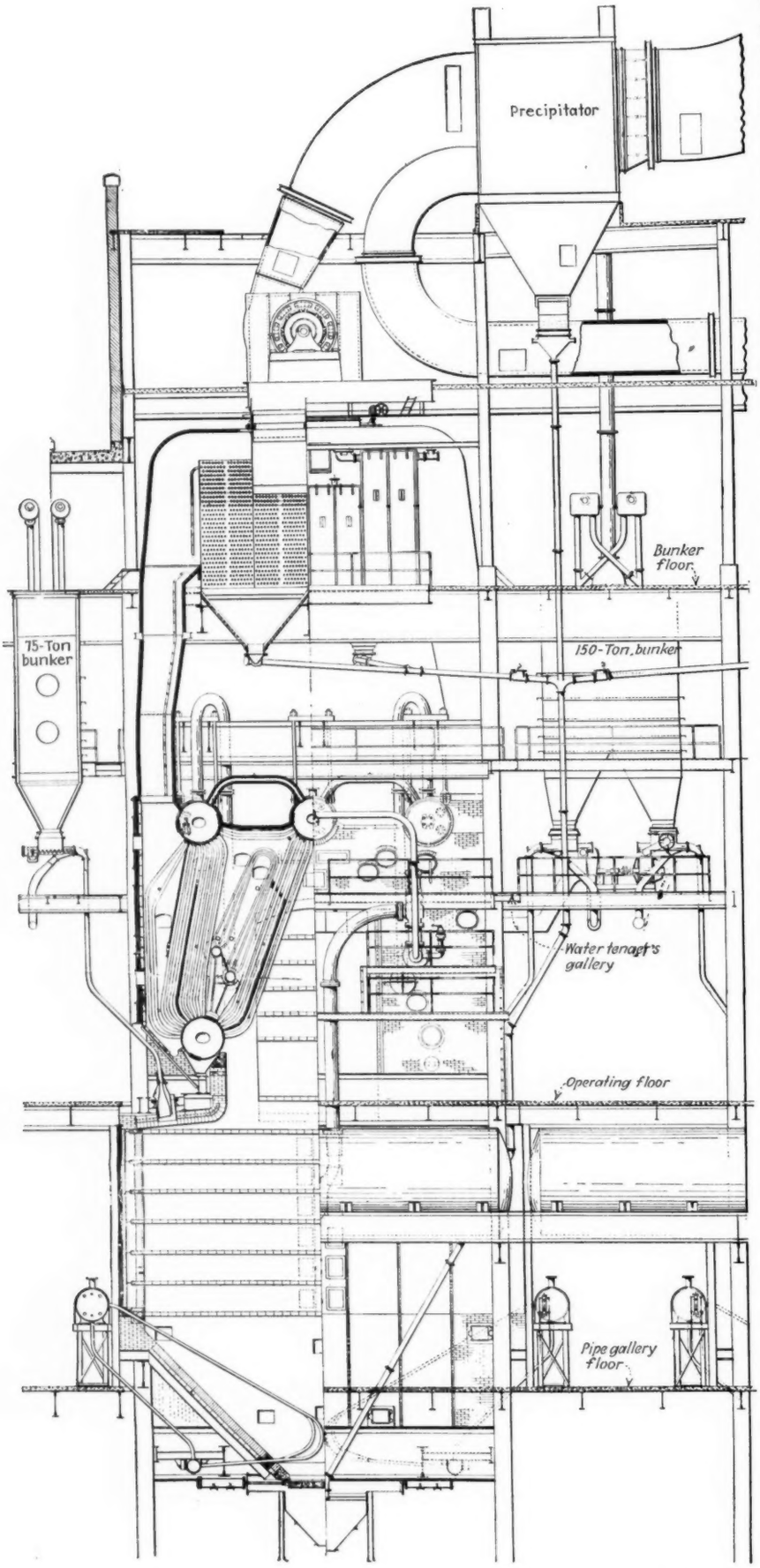


Fig. 2—Section through boiler house showing great height of settings

trolled by a manually operated 50-in. valve. This design has the advantage of simplifying the governor control mechanism, since it eliminates all cams, shafts, etc. The hydraulic cylinder under governor control acts directly on the stem of the main control valve, which admits steam into the entrance elbow, from which a small branch leads steam to the fifth-stage shell. In operation it is expected that this arrangement will prove satisfactory. When added capacity is required, above the best point of the turbine, the hand valve can be opened, and the operator will know that he is securing additional capacity at the expense of economy, and he will be on the alert to close the valve again as soon as possible

With their axes crosswise of the turbine room the machines are placed in what will ultimately be a grouping in three pairs, with large hatches between pairs for light and access to the condenser room. This arrangement of main units calls for a crane of 100 ft. span, but, all things considered, it seems to give the most economical layout for the conditions at Trenton Channel.

It has been stated previously that the auxiliary power system is independent of the main station bus, because the main bus voltage is to be varied over a considerable range, so that interconnections within the station would demand additional regulation, with opportunities for confusion and trouble. In consequence of this there are two distinct auxiliary power plants within the station, one for direct and the other for alternating current.

All essential auxiliaries within the power station proper are driven by direct-current motors, because this type seems to furnish the most satisfactory means of securing the range of speed variation necessary in many instances, and desirable in others. In the present installation the direct-current bus is fed by three generators driven through gears by steam turbines. Each generator is rated at 4,000 kw. and comprises two machines of one-half that size, combined in one. The two rotors, each with its own commutator, are mounted on the same shaft, which is carried by a single pair of bearings. The turbines are of the two-barrel type, two turbine rotors driving separate pinions on opposite sides of the main gear. The high-pressure turbine runs at 4,000 r.p.m., the low-pressure machine at 3,000, and the generator at 360 r.p.m.

To insure complete reliability of service, these direct-current generating sets have been designed for 50 per cent continuous overload, and it is planned always to run sufficient units so that should one drop off the bus, the others can carry the load.

The turbines have been designed for straight condensing operation, river water being used for condensing the exhaust. The alternative is to exhaust these turbines at high pressure, using the steam for heating feed water; but such a system almost demands a connection between the main and auxiliary electrical systems, since only in this way is there any possibility of adjusting the quantity of exhaust steam to the requirements for feed-water heating. As this interconnection was ruled out at Trenton Channel, it seemed inadvisable to attempt any scheme for utilizing the auxiliary exhaust steam, especially in view of the use of three stages of extraction heating, followed by economizers. Curiously enough, both first cost and thermal economy of this arrangement seem to work out favorably, in comparison with motor-generator sets driven from the main system, with house alternators in reserve.

To avoid dangerous voltages to ground the direct-current voltage, 250 volts, was deliberately chosen rather low. The direct-current system runs all over the plant, often to rather small motors, and it has seemed wise to use heavy copper conductors to avoid the dangers incident to higher voltages in places readily accessible to workmen.

In the coal-preparation house it was considered safer to use alternating-current motors, because they have no commutators, with the possibility of sparking and susceptibility to dirt. Accordingly, in the turbine room there will be initially two 2,000-kw. turbo-alternators, energizing a bus at 2,300 volts. Some of the larger motors will operate on this voltage, while smaller machines will be served through transformers.

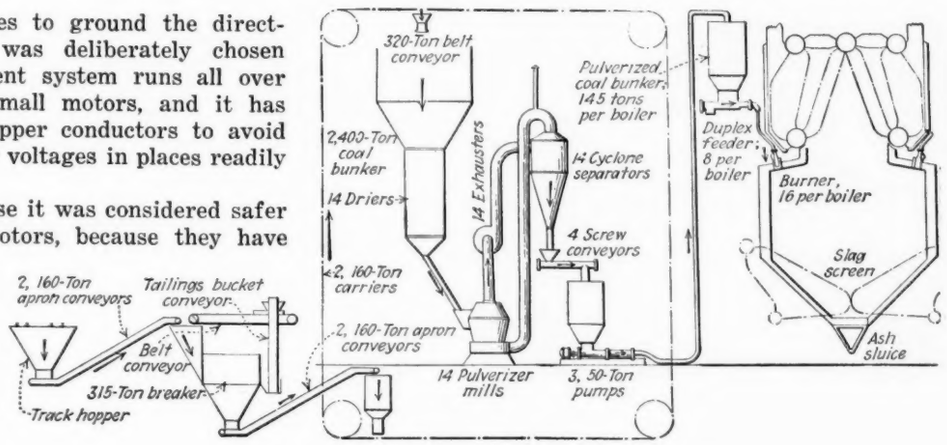


Fig. 3—Diagram of coal-preparation system

Only ordinary precautions have been taken to safeguard continuous operation for this system. The generating capacity installed includes no large margin of excess, and therefore a connection from a near-by substation has been installed, treating this portion of the power station exactly like any large power customer. The plan is to operate one of the turbo-alternators in parallel with this system connection, with the other house machine standing by in readiness to start if the other machine or the system connection should drop out. In such an event there might be a brief interruption of service to the motors, but all the auxiliaries driven from this source are in the so-called non-essential class; that is, their running may be interrupted for a considerable period without jeopardizing the continuous operation of the plant as a whole.

To facilitate quick starting of the house turbo-alternators, their condenser auxiliaries will be driven by alternating-currrent motors, connected directly to the terminals of the generator, so that when the machine is started, its auxiliaries will start with it. The condenser and circulating pump will be kept primed from the main circulating water priming system. The vacuum pump is of the water-jet type, and its centrifugal water pump also will be kept primed in the same way. Should any of the auxiliaries be cut out for repair or other reasons, an atmospheric relief valve will permit the unit to run with free exhaust.

The main condensers are bolted directly to the turbine exhaust flanges, with car-spring supports to carry a large share of the condenser weight. They are of the single-pass type, with some 50,000 sq.ft. of surface made up of 1-in., 18-gage Admiralty tubing in 24-ft. lengths. The condensers are of unusual design in several details. They are built with shells of circular cross-section, but with the tube sheets set eccentric to the shell, the center of the tube sheet being vertically below the center line of the shell. This leaves a crescent-shaped steam belt on both sides of the tube bundle, wide at the top and narrow at the bottom.

On one side of the condenser this belt is used to admit steam direct to the bottom of the condenser, to reduce the chilling of condensate. The flow, however, is controlled by dampers which are operable from outside by means of valve bonnets. On the other side of the condenser this crescent-shaped space is used as an equalizing chamber on the suction of the dry-vacuum pumps. A baffle is installed tight against the tube bundle, and air enters through a slot 1½ in. wide for the full length of the condenser.

The tubes are arranged close together along radial lines, so that the steam may enter the cooling surface through a large number of lanes, separated by single rows of tubes, the lanes tapering from about 4 in. wide at the top of the condenser to a point near the bottom where the spacing is as close as is feasible.

Approximately one-quarter of the condenser is set apart as an air cooler, being separated from the steam-condensing section by suitable baffles. In summer steam will doubtless sweep over into this cooling section while in winter condensation will be complete before the bottom of the condenser has been reached.

To control the flow of cooling water, the inlet water box is tapered, being thick at the bottom and thin at the top. Water enters from both pumps through nozzles directed vertically upward, both on the same side of the vertical center line. This is expected to give the water a rotary motion across the tube sheet, favoring flow through the widely spaced tubes at the top, which are most exposed to the entering steam and therefore must do more work than tubes in the air-box, for instance, which is the last section reached by the inlet water.

With a condenser of the single-pass type it is necessary to have a dam in the overflow box to keep the top tubes full. This dam is parallel to the tube sheet, and in the space between there are two sets of butterfly valves, operable from outside the condenser, whereby the flow of water to the lower quarters of the condenser can be reduced at will. This makes it possible to economize on circulating pump power in winter and at the same time to maintain effective condensing action. The hotwells have been made exceptionally large, so as to give sufficient storage capacity to stabilize the operation of the pump and heater system.

Condensers serving both the direct- and alternating-currrent house turbines are of small size and standard design. The 4,000-kw. direct-current machines have condensers with 7,500 sq.ft. of surface, and the 2,000-kw. alternating-current machines are served by 4,100-sq.ft. condensers.

The main circulating pumps, two for each main condenser, are 48-in. pumps, rated at 60,000 gal. per min. each and designed to deliver 100,000 gal. per min. when both are on together. They are driven by 325-hp. direct-current motors, with a range of speed from 175 to 255 r.p.m. The auxiliary condensers are served by smaller centrifugal pumps, one for each condenser, those serving the house turbo-alternators being driven by alternating-current motors and the circulators for the direct-current machines from the direct-current auxiliary service.

The main condensers and the condensers serving the house service direct-current units have reciprocating vacuum pumps driven by directly connected direct-current motors. The main pumps are of the vertical

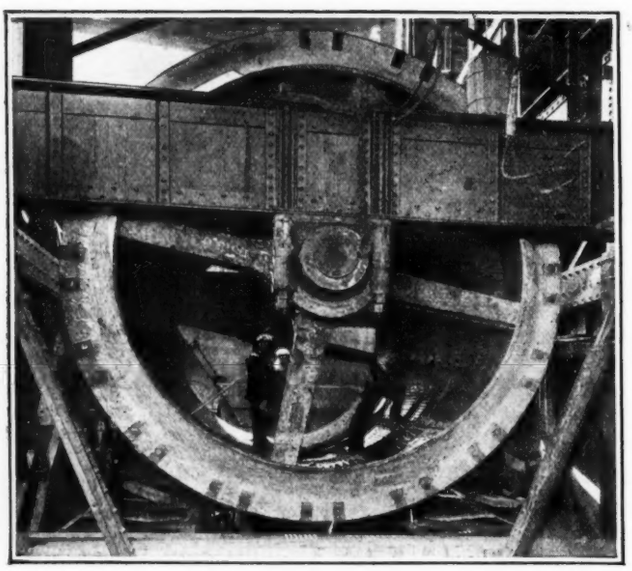


Fig. 4—Erecting huge coal breaker, which has a capacity of 315 tons per hour and breaks the coal to pass a 1¼ in. ring

type while the auxiliaries are horizontal. All are of the single-cylinder, single-acting type, with feather valves.

For the house alternating-current units the condensers are served by water-jet vacuum pumps. These were chosen because it is desired to have the motors for these machines connected to the terminals of the generator of the unit which they serve, so that the pumps will start with the unit. It was not deemed wise to start reciprocating pumps from a remote point.

As has been the practice in other plants of the company, a priming header is connected into the tops of the water-boxes of all main condensers, so that all idle condensers and circulating pumps are constantly primed, except when they are intentionally shut off.

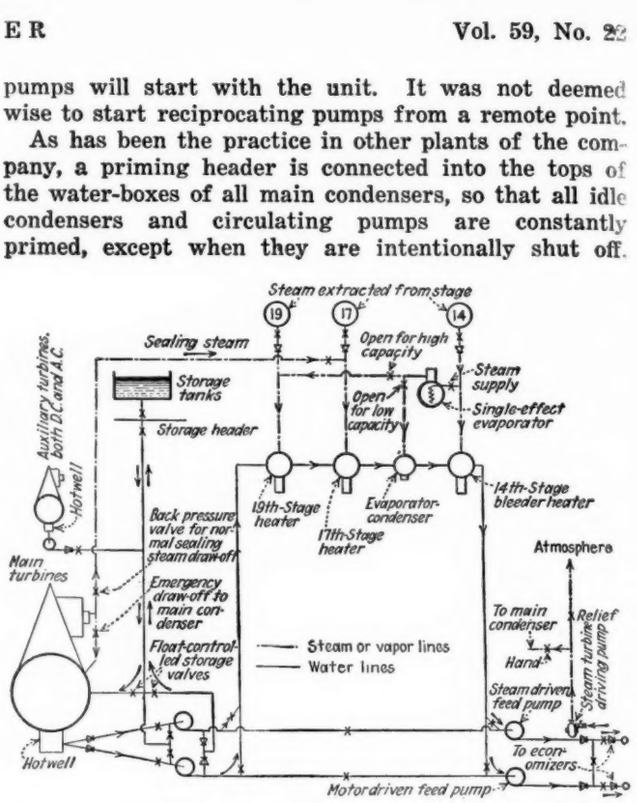


Fig. 5—Simplified feed-water diagram showing bleeder connections, evaporator hookup and storage-tank connections

At Trenton Channel the auxiliary condensers and circulators and the water-jet vacuum pumps for the alternating-currrent auxiliary machines are connected to this priming header. This scheme makes it possible to start any of these pumps whenever desired, without delay for priming the pumps.

Within the plant the intake canal runs along the axis of the turbine room under the condensers. It is fed at the center by a tunnel from the river, perpendicular to the axis of the turbine room, so that in plan the canal is roughly similar to a T-square, with the head running under the condensers, and the blade leading in from the river. Now imagine a second strip attached to the T-square blade, parallel to the head and a short distance from it. This represents a second intake for the condensers serving the direct-current house machines. The intake is protected by revolving screens, nine in number, located in a screenhouse near the river bank. In front of these, but within the same building, are heavy trash racks.

The overflow canal lies on top of the intake canal under the condensers, but discharges on the opposite side of the plant, into a narrow open canal that separates the island from the mainland. A branch of the overflow canal runs over the top of the intake tunnel to the screenhouse, and gates are provided whereby warm water may be discharged in front of the screens for fighting ice formations.

Two pumping units are installed for each main condenser, each unit consisting of a hotwell pump and a boiler-feed pump, rigidly coupled together to form what is called a combination pump. For each unit there is one combination pump driven by a direct-current motor, with a standby set driven by a steam turbine.

Normally, the motor-driven units will be operated

under manual control to maintain the boiler-feed pressure, and the rate of discharge will be adjusted to give the desired distribution among the units. The steam turbines driving the standby units are arranged to exhause into the main condensers through a hand-operated gate valve, or to atmosphere through an automatic relief valve. Of course the hand valve will be closed normally, and the units, if started without warning, will exhaust to atmosphere. Then, if the condenser is running properly, the operator will open the hand valve, the automatic relief valve will close and water-seal itself, and the turbine will run condensing. The object is not to secure economy, but to save steam and avoid having to carry this turbine for any considerable period on the evaporators. The turbine is a single-wheel machine designed especially for starting quickly without preliminary warming up. It is expected to start just as promptly and as easily as an electric motor.

Storage Tank so Connected as To Keep Air Out of System

For each combination set the hotwell pump draws water from the condenser hotwell and discharges it through the stage heaters to the suction of the boiler-feed pump which delivers to the main and auxiliary feed headers.

At times of varying station load, a closed system of this sort will fail to meet the requirements, and provision must be made for the transfer of excess water to storage during periods of increasing load and of water from storage into the active system during periods of decreasing load. At Trenton Channel this will be controlled automatically by a float mechanism responding to the level of water in the condenser hotwell, and controlling the opening of two valves, one of which admits water from storage into the condenser when the hotwell level is low, the other of which bypasses water from the discharge of the hotwell pump to the storage system when the hotwell level is high. In an intermediate neutral zone of condensate level, both valves are closed.

Water discharged into the storage system is cold condensate, so that no heat is wasted needlessly. Water returning from the storage system is introduced into the main condenser, well up the side of the shell on the air cooler side, through a trough which extends longitudinally and spills this water in a thin sheet down the side of the condenser. Since the storage tanks are to be steam sealed, to exclude air, the water returning from storage will carry little dissolved oxygen, and it is expected that whatever there may be, will be reduced during the passage through the main condenser to such a point that economizer corrosion will be prevented. The speed of the combination pump will be controlled manually so as to maintain the desired boiler-feed pressure and distribution of load among the pumps running in parallel.

Condensate from the auxiliary condensers will be pumped into the storage-water piping system and will enter the main condensers through the storage-water return valves and thus return to the boilers through the combination pumps.

A preliminary study of various arrangements for heating feed water and recovering otherwise waste heat indicated the desirability of following the regenerative cycle, in which steam is extracted from the main turbine for heating the feed water in several stages. To reduce the loss of heat in flue gas, it was considered preferable to use steel-tube economizers rather than air preheaters, because air preheaters are still in the development stage and also because the furnace design calls for air-cooled walls, which in themselves preheat the air. The effectiveness of an economizer decreases as the water coming to it is hotter, and therefore the decision to use an economizer made it necessary to confine the heating of water with extracted steam to the lower ranges of temperature. An extensive study of the matter was carried out, including everything that could be predicted with regard to the thermal performance of the equipment, as well as such practical limitations as were imposed by manufacturing conditions.

The result of the studies made was the decision to draw steam from the fourteenth-, seventeenth- and nineteenth-stage shells; that is, from the space in which the correspondingly numbered wheels rotate. This point settled, there remained several questions: What shall be done with the makeup water evaporators? What disposition shall be made of the drips from the stage heaters and the evaporators? What shall be done with high-pressure steam drips? Studies were made of several arrangements, and the scheme finally selected is regarded as the most satisfactory with respect to the combination of thermal economy, operating convenience and first cost.

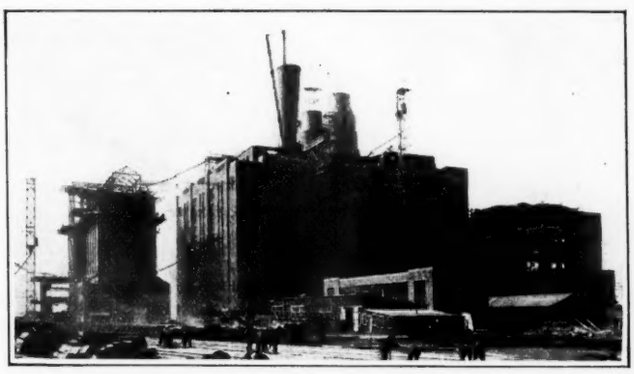


Fig. 6—General view of station under construction

The makeup evaporator will be a single effect, submerged-surface type, drawing its heating steam from the fourteenth stage of the main turbine, in parallel with the fourteenth-stage heater, and discharging its vapor to a separate condenser which receives condensate leaving the seventeenth-stage heater, and discharges it to the fourteenth-stage heater. The evaporator has been designed for a normal operating rate equivalent to about 1¼ per cent makeup. When higher rates are desired, the vapor produced in the evaporator can be discharged into the nineteenth-stage heater.

Approximately 5 per cent of the total steam passing the throttle will be drawn off from each bleeder connection. The stage pressures naturally vary with turbine load, and the respective heater pressures will be somewhat below the turbine pressure at the bleeding point, owing to frictional drop in the connecting piping. The water temperature attained in the heaters will be somewhat below the boiling point corresponding to the steam pressure in the heater. These facts have all been included in preparing Table I showing expected operating conditions, for a condenser pressure of 1 in. of mercury, absolute.

In this table the lines designated by *C* indicate the temperature of condensate leaving the hotwell pump. It is assumed that condensate leaves the condenser hotwell at 70 deg. F. and that it is warmed by the admixture of drips from the stage heaters. This gives the final temperatures indicated. The lines designated

TABLE I.—EXPECTED OPERATING CONDITIONS FOR CONDENSER PRESSURE OF 1 IN., ABS.

Turbine Load, Kw.	Stage	Stage Pressure, Lb. per Sq.In. Abs.	Temp. of Water Leaving Heater, Deg. F.
50,000	*C*	.....	81.5
	19	3.43	126.0
	17	10.54	182.2
	E	11.57	194.2
	14	34.93	246.7
	C	.....	79.8
42,600	19	2.80	119.3
	17	8.50	173.0
	E	9.58	185.2
	14	28.00	234.1
18,200	*C*	.....	75.5
	19	1.40	99.1
	17	4.14	144.1
	E	6.41	166.8
	14	13.47	198.4

by numbers give data computed for the stage heaters drawing steam from the correspondingly numbered turbine stages. The lines designated by *E* refer to the evaporator condenser.

The steam extraction connections vary from an 8-in. line from the fourteenth stage to a 24-in. line from the nineteenth stage. Each line is fitted with a manually operated gate valve and with a check valve to prevent return flow. To secure the minimum pressure drop, the check-valve poppets have been made of duralumin and the simplest available design of valve has been used. Corrugated copper expansion joints have been used to avoid temperature stresses.

The heaters are of the straight tube type, with the tubes expanded into tube sheets at both ends, one tube sheet being mounted on a floating box, to care for expansion. Together with the evaporator and its condenser each set of heaters is located just below the turbine-room floor, as close to the turbine as possible, so that the connecting piping is no longer than necessary.

All house turbines are of the extraction type, delivering steam into a header in which the pressure is maintained between 15 and 20 lb. per sq.in. gage. This heater serves the building heating system and the coal driers.

Each main generator is equipped with a closed-circuit ventilation and cooling system. The coolers, of the finned-tube type, are mounted below the generator and receive cooling water from the inlet water-box of the main condenser, discharging to the overflow canal. During the colder months, when the condensate is sufficiently cool to do the work, it will be passed through the coolers instead of river water. The connections are all equipped with double valves, with bleeders between, so as to reduce the possibility of mixing river water with the condensate or of discharging condensate to the river.

The boiler room is laid out for three rows of boilers, one set of three for each main turbo-generator. For the present installation only eight boilers are being installed, one position being left vacant. The boilers are of the Stirling W type, with the steam drums designed for 415 lb. per sq.in., gage working pressure. The drums are 48 in. outside diameter, with plates 2 in. thick. The heating surface is 29,087 sq.ft. in the boiler proper. Each boiler has two superheaters, with 6,070 sq.ft. of surface, two economizers with 18,984 sq.ft., and a pair of tube screen boilers with 1,220 sq.ft. It is expected that the economizers will raise the temperature of feed water by some 80 deg. F., and that the superheaters will deliver steam at a temperature of 700 deg. normally and never exceeding 725 degrees.

Each boiler is fitted with four water columns, having high- and low-water alarm whistles, and with two feed-water regulators. On the center drum there are eight 4½-in. safety valves, which are set to blow in pairs, two at 415 lb. per sq.in. gage, two at 417, two at 420 and two at 425. On the outlet of each superheater there are two 4½-in. safety valves, set to blow at 405 lb. per sq.in. There is a non-return valve on the outlet of each superheater.

Bypass Between Superheaters

When two superheaters must work in parallel, with separate non-return valves, it is necessary to introduce a rather large drop in pressure through the superheater so as to make certain that the non-return valves will stay open. When one valve is stuck shut, the pressure difference acting on its disk is equal to the pressure drop through the other superheater and its non-return valve. If this pressure drop is small, it may be insufficient to open the stuck valve, and the corresponding superheater, having no steam flowing through it, will overheat quickly. The remedy is to introduce a large pressure drop through the superheaters, so that if a valve sticks, it immediately will have to sustain the entire pressure drop through the other unit, which will be large enough to open the stuck valve promptly. The disadvantage of this arrangement is that the large pressure drop involves a continuous loss in normal operation. To avoid this, the boilers at Trenton Channel are equipped with a 6-in. pipe bypass between superheaters, inside the non-return valves. With this arrangement, if one valve should stick, steam will still flow through its superheater, through the bypass, and out through the other non-return valve. Thermometers are to be installed to indicate the temperature of steam at each superheater outlet, and these will indicate at once any cessation of flow through either unit.

In the hopper-shaped furnace bottom protection is afforded against overheating and slag formation by a tube screen, which is made up of two independent boilers. Each screen boiler has two water columns, with high- and low-water alarms, two 4½-in. safety valves, set to blow at 420 and 425 lb. per sq.in., gage, and a feed-water regulator. The steam formed in the screen boilers is discharged through separate non-return valves into the top center drum of the corresponding main boiler. Here it mingles with the saturated steam formed in the main boiler, and passes with it through the circulating tubes into the outer drums, and thence to the superheaters. This arrangement protects the main boiler against accident due to failure of any part of the tube screen.

Each boiler is served by a duplex economizer made up of 2-in. steel tubes expanded into steel headers. The water and gas flow is counter-current, and it is expected that the water temperature rise will be some 80 deg. F., the gas temperature decreasing some 240 deg. under normal operating conditions. The water may be bypassed around the economizer, but there is no gas bypass. The economizer is considered to be a part of the boiler, and if it fails, the unit will be shut down

as quickly as possible, just as it would be for failure in the boiler itself.

The furnace is built with double walls, with air circulation through the intervening space serving to keep the wall cool and to warm the air for combustion. From the bottom of the furnace to the top of the "steeple" between the inclined boiler tubes, the vertical height is 60 ft. In plan the furnace is 23x34 ft. and the furnace volume is about 25,140 cubic feet.

Under each mud drum of the main boiler is an arch through which the pulverized-coal burners shoot their flame vertically downward. There are 16 burners per boiler, 8 on each side. These flames pass downward across the face of a wall in which there are scattered many openings through which secondary air is admitted, after passing between the inner and outer walls, where it is warmed somewhat. Turning upward, the flames from both sides of the setting meet in the center and pass upward into the boiler, where the gas stream splits, half passing through each side of the boiler and economizer, to meet again in the induced-draft fan.

These fans are on the upper floor of the boiler house and are driven by directly connected direct-current motors. They discharge the flue gas into breechings that are arranged so that one stack serves three boilers. Each outside fan discharges directly into the end of the breeching, and the center fan is built with a double discharge, sending half of its gas toward each outside fan, through a duct that turns into the main breeching.

Electrostatic Precipitation of Ash Dust

Passing through an outer housing, the breechings enter the base of the stack from opposite sides. Between the breeching proper and the housing, air is drawn into the upper floor of the boiler house for ventilation. In each breeching of one battery (that is, one stack) is an electrostatic dust precipitator for removing the fine ash dust which might otherwise be blown out of the stack. This installation, which is something of an experiment, has been made with a view to determining what can be done in the way of eliminating stack dust. The apparatus consists of a series of vertical steel plates, in the path of the gas, thoroughly grounded, with wires strung between them, supported by insulators and kept charged at about 30,000 volts direct current. The necessary power at the desired voltage (which is subject to adjustment) is obtained from a small transformer through a commutator driven by a synchronous motor.

At the bottom the furnace is hopper-shaped and is closed at the center by a pair of sliding ash gates, operated by compressed air cylinders with manual control. These open into a sluiceway that runs lengthwise of the boiler house under each of the three rows of boilers. For the present the ash will be sluiced into a basin near the plant, from which it will be removed by dredge pumps for use as fill on the property. Ash is collected by hoppers under the economizers and under the precipitators, and is conducted in pipes to the sluices, with water jets to promote flow.

Each boiler, having two superheaters, has two steam outlets. From these steam is led to a Y-fitting, from which a single pipe carries it through the boiler-room floor, where it enters a large cast-steel special tee fitting. These tees are tied into a network which serves to distribute the steam with considerable flexibility.

Since there are three rows of boilers, there are two longitudinal aisles. Under each of these is a longitudinal header. At each row of boilers there is a cross-over between these two headers, and the steam from that row of three boilers enters at the two ends and at the center of this cross-over connection. From the center steam is taken off to the corresponding main turbine.

Corresponding to each main unit there is a steam connection to a manifold from which steam is supplied to the house turbines in that section of the plant. From the tabulation of data given at the end of this article, it will be noticed that the throttle pressures cited for the main and house turbines are not identical. Some effort has been made to estimate the probable pressure drops to these several machines, and the results, together with the pressures for which the turbine manufacturers had designs worked up, determined the values established.

The entire high-pressure piping system has been designed with a view to keeping stresses down to a minimum value without the use of slip joints. Accordingly, bends and loops have been used freely. With pipe of 14-in. outside diameter, and with ½-in. walls, long offsets are required to provide sufficient flexibility. All the main steam piping is seamless steel tubing, with Van Stone joints.

Coal Handling and Preparation

Coal is to be received exclusively by rail, since the branch of the Detroit River on which the plant is situated is too shallow for large boats or barges. The incoming coal will be weighed on track scales and thence pass either to stock or to the dumping hoppers.

Coal stocking and reclaiming will be handled as at other plants of the company, by locomotive cranes with grab buckets. Coal entering the plant will be dumped into concrete hoppers below ground level. Two tracks run over the hoppers, so that it will be possible to dump four cars at once.

Over one track there is a coal-car unloading machine, of the type originally designed by J. P. Considine for unloading flat-bottomed cars and for breaking up frozen coal. This machine is a development, with many changes in detail, of the original machine[1] in service at the Delray station.

From the bottom of the track hoppers coal is carried upward on an inclined apron conveyor and delivered to the feeding hopper of a Bradford breaker, which will break the coal to pass through a 1¼-in. ring. Tailings from the breaker will be handled over a picking belt and returned to the entrance of the breaker. Material that will not break will thus pass through the breaker repeatedly until it is detected and picked out by hand.

The broken coal is fed to a bucket conveyor by which it is elevated and delivered into a 2,500-ton crushed-coal bunker at the top of the coal preparation house. From the bunker coal feeds by gravity through driers to the pulverizing mills.

A new type of drier is employed. Air will be passed through the descending stream of coal in a chamber traversed by steam-heated surfaces. The steam used will be extracted from the house turbines, and therefore the heat will be secured at low cost. Steam is so much easier to transport than flue gas that it is believed that this plan will show a material net saving. It will be both flexible and easy to operate.

At the bottom of the drier a star feeder passes the coal along to the pulverizers. Carried upward by the

[1] See *Power*, Oct. 12, 1915, p. 502.

stream of air passing through the mill, the fine coal is separated from the air in a cyclone separator and passes to a screw conveyor which carries it into the feeding hoppers of a set of screw pumps by which the powder is distributed among the individual boiler bins.

Each boiler has two bunkers, each of 75 tons capacity, and from each bunker four twin feeders, driven by variable-speed motors, deliver coal to eight burners on that side of the boiler. Primary air blowers carry the fuel into the furnace, where it ignites, the combustion being supported by the secondary air which enters through the ventilated setting walls.

At strategic points in the main steam piping system there are motor-operated valves, the push buttons of which are in a room adjoining the bridge between the plant and the office building. These valves may be closed individually or collectively from this remote point, but cannot be opened from there. Operation at the valve is entirely manual for both opening and closing.

Flowmeters indicate the rate of steam flow to the main turbines and the rate of discharge of the boiler-feed pumps. Vacuum gages (with the plant barometer) indicate the condenser pressure. Thermometers indicate water temperatures at various points in the system of extraction heaters, and gages indicate the steam pressures. By means of these instruments the operator can check the performance of the entire outfit from the thermal point of view.

For conducting a steam rate test, special provisions were necessary, since, of course, the condensate from the unit under test must be weighed, and this can be done accurately only before the water is heated. Then the weighed water must be passed back through the extraction heaters supplied with steam from the turbine under test and thence passed to the boiler-feed pump. Means must be provided for insuring that no water passes either to or from the storage system. For boiler testing the necessary details are somewhat different, but are of the same general nature. For both these contingencies full provision has been made, in both piping and instruments, so that accurate tests can be conducted whenever it seems desirable.

Combustion instruments and controls are mounted on a board for each boiler unit. The instruments comprise pressure gages for feed water, main boiler saturated steam, tube screen saturated steam and superheated steam; gages, indicating draft at five points within the setting; ammeters, indicating the current drawn by blower and feeder motors; and air-flow steam-flow meters. On this board are mounted controls for motor feed for the coal feeders, the primary air blowers and the induced-draft fans. A reversing switch controls a small motor that actuates the dampers. On one boiler unit an automatic air-flow steam-flow control is to be installed, with a view to studying its operating characteristics.

On either side of each boiler-control board are the main and auxiliary valves controlling feed water entering the corresponding tube-screen boilers. A periscope will make the water glass visible to the operator, who is on the floor above the tube screen drums.

In the turbine room is a central gage-board, on which appear instruments indicating or recording the quantities essential to a grasp of the operating conditions prevailing through the station. Here the operating engineer in charge of the shift on duty will have his desk.

The electrical control of both main and house generating sets is in the main switch-control room, which is on the west side of the turbine room, with bay windows overlooking the turbine room on the one hand and the outdoor switch gear on the other. All transformers and main breakers, with lightning arresters and disconnects, are out of doors. Between each main generator and its transformer is a three-phase oil switch within the station building. Thus there are two switches in series between each generator and the bus, one at 12,200 volts and the other at 120,000 volts. Service switches for the auxiliary system are distributed at convenient points in the station.

All recording instruments and the station clocks are to be driven by synchronous motors, from the system connection to the house service from a near-by substation. The frequency will be that of the main system, which is carefully regulated with the aid of master synchronous clocks. Should this connection be open, the clock motors will be driven by a small motor-generator set driven from the direct-current house bus, with an automatic frequency control. The throw-over will be automatic.

The station is rapidly nearing completion, and probably will be delivering current commercially within two months. Just what the station economy and operating characteristics will be, time alone can tell. Predictions at this time would be futile. After a few months actual results may be available with sufficient accuracy to justify their publication.

DATA ON PRINCIPAL EQUIPMENT IN TRENTON CHANNEL PLANT OF THE DETROIT EDISON CO.

GENERAL

Location	Slocum's Island, 18 miles south of Detroit
Character of service	Light and power
Capacity present building, kw.	150,000
Capacity, ultimate, kw.	300,000
Boiler room for 9 boilers, ft.	189 x 166
Turbine room for 3 units, ft.	106 x 180
Type of construction	Steel, concrete and brick
Foundations	Footings on rock
Floors	Concrete, reinforced
Engineers and constructors	The Detroit Edison Co.

IMPORTANT RATIOS

Boiler-heating surface to installed kw.	1.55
Furnace volume to installed kw.	1.34
Furnace volume to boiler surface (including water screens)	0.83
Condensing surface to installed kw.	0.95
Circulating water, gal. per min., to installed kw.	2
Installed kw. capacity to boiler-feed pump capacity in gal. per min.	19

BOILERS, SUPERHEATERS AND ECONOMIZERS

Manufacturer	Babcock & Wilcox Co.
Type of boiler	Class W, type 53, Stirling
Number installed	8
Steam-making surface per boiler, sq.ft.	29,087
Tube diameter, in.	3½
Size of drums	48 in. diam., 28 ft. 6 in. long
Furnace volume, cu.ft.	25,140
Sq.ft. of steam-making surface per cu.ft. of furnace volume	1.16
Water screen at bottom of combustion chamber, 3½-in., No. 6 B.w.g. effective heating surface, sq.ft.	1,220
Boiler pressure, lb. gage	415
Superheat, deg. F.	255
Total steam temperature, deg. F.	707
Type of superheater	Twin triple U-tube
Location of superheater	Between passes
Superheating surface per boiler, sq.ft.	6,070
Ratio superheating to steam-making surface.	0.208
Economizers, two per boiler	Duratex
Tube diameter, in.	2
Surface per boiler, sq.ft.	18,984
Ratio economizer to steam-making surface.	0.654
Soot blowers, Diamond	Diamond Power Specialty Corp.
Feed-water regulators, Copes	Northern Equipment Co.

STACK AND DRAFT EQUIPMENT

Builder	Toledo Metal Mfg. Co.
Number	One for every three boilers
Type	Venturi shaped, steel, brick lined
Diameter at top, inside, ft.	21
Diameter at throat, inside, ft.	15

DATA ON PRINCIPAL EQUIPMENT IN THE TRENTON CHANNEL PLANT (Concluded)

STACK AND DRAFT EQUIPMENT (Continued)

Height above burners, ft.-in.	190-4
Support	On building steel
Fans, induced draft	American Blower Co.
Number	One per boiler
Type	Double-inlet Sirocco
Capacity at 7.15 static pressure, cu.ft. per min.	193,000
Drive	General Electric d.c. motor, 350-hp., 240-v., 460 to 120 r.p.m.
Precipitators (Cottrell) to remove refuse from flue gases, two for three boilers	The Research Corporation

FUEL

Kind	Bituminous coal
Heat value, B.t.u. per lb., dry	13,200

FURNACES

Type	Ventillated wall
Ash gates, 3 per boiler, 4 double sets	Arrow—Baker Dunbar Co.
Furnace volume, cu.ft.	25,140
Ratio furnace volume to boiler-heating surface (including water screens)	0.83

RAW COAL HANDLING EQUIPMENT

Track unloading pit, with J. P. Considine car unloader	Brown Hoisting Mchy. Co.
Apron Conveyor, 42 in., 160 tons per hour	Link Belt Co.
Coal breaker, Bradford, 315 tons per hour	Pennsylvania Crusher Co.
Drive	General Electric motor, 150-hp., 3-ph., 60-cycle, 2,200-v., 720 r.p.m.
Tailings from and to breaker	24 x 15 in. Chain Belt bucket conveyor and 24-in. Robins belt conveyor
Coal from breaker to green coal bunkers—Two 42-in. apron and two 36-in. bucket conveyors	Link Belt Co.
Distributing conveyor over bunkers, 36 in.	Robins Conveying Belt Co.
Magnetic pulley, 36 in. diam.	Dings Magnetic Separator Co.
Bunker capacity, tons	2,500
Storing and reclaiming, locomotive cranes	Brown Hoisting Machinery Co.

PULVERIZED COAL EQUIPMENT

Driers	Under development
Pulverizers, Raymond, 6-ton	Combustion Eng. Corp.
Drive	General Electric motor 100 hp., 450 r.p.m., 2,200 v., 3 ph., 60-cycle
Exhausters	1 per mill, 6,000 cu.ft. per min.
Drive	General Electric ind. motor 60 hp., 2,200 v., 1,200 r.p.m.
Conveyors, screw, four (two for spares) tons per hour, each	100
Coal pumps, 3 Fuller-Kinyon, 50 tons per hr.	Fuller-Lehigh Co.
Bunker capacity, tons per boiler	150
Feeders, duplex Lopulco, 8 per boiler	Combustion Eng. Corp.
Drive	General Electric d.c. motor, 2 hp., 300-1,200 r.p.m.
Burners, Lopulco fishtail, 16 per boiler	Combustion Eng. Corp.
Blowers, primary air, two per boiler	Buffalo Forge Co.
Capacity of each, static press. 15 in., cu.ft. per min.	6,500
Drive	General Electric d.c. motor, 30-hp., 240-v., 1,600 to 1,200 r.p.m.

ASH HANDLING EQUIPMENT

Manufacturer	Baker Dunbar Co.
Type	Hydraulic sluicing delivery to basin near plant
Pumps, 3 single stage, 2,000 gal. per min.	DeLaval Steam Turbine Co.
Drive	General Electric motor 60-hp., 2,200-v., 3-ph., 60-cycle, 1,200-r.p.m.

FEED PUMPS AND AUXILIARIES

Combination boiler-feed and hotwell pumps	De Laval Steam Turbine Co.
Number	6
B. F. pumps, 6-stage, 1,300 gal. per min.	1,090 ft. total head
Hotwell pumps, single stage	1,500 gal. per min.
Drive of 3 pumps	700 hp., d.c., 240 v., Westinghouse motor, 1,200 to 1,000 r.p.m.
Drive of 3 pumps	Single-stage DeLaval turbines
Feed-pump control	Manual
Service pumps, 3 two-stage, 2,400 gal. per min.	DeLaval Steam Turbine Co.
Drive	Two pumps driven by 240-hp., d.c. 240 v., motors, 1,700 to 1,200 r.p.m.—One pump driven by single-stage DeLaval turbine
Control of pumps	Manual
Stage heaters, closed, condenser type	Griscom-Russell Co.
Number	3 for each main turbo-generator
Surface in each heater, sq.ft.	2,622
Evaporators and condensers for makeup—Reilly	Griscom-Russell Co.
Number	One for each main turbo-generator
Capacity to evap. raw water per hour, lb.	6,625

MAIN GENERATING UNITS

Manufacturer	General Electric Co.
Turbine	21-stage, horizontal Curtis
Steam for extraction from stages 14, 17 and 19	
Steam conditions at throttle	375-lb. gage, 258 deg. F. superheat
Speed of unit, r.p.m.	1,200
Number of units	3
Rating, kva	62,500
Generator	3-phase, 60-cycle, 12,200 volts
Exciter, shaft driven	250-kw., 250-volts
Generator ventilation, closed system, cu.ft. per min	120,000

Guaranteed performance with no bleeding:

Kilowatts	25,000	35,000	42,500	50,000
Lb. steam per kw.-hr.	9.95	9.60	9.40	9.70

CONDENSERS AND AUXILIARIES FOR MAIN UNITS

Manufacturer	Worthington Pump & Mach. Corp.
Number	3
Type	Single-pass surface
Tube surface, each, sq.ft.	47,300
Tube diameter	1 in. o.d., No. 18 gage
Circulating pumps, 2 per condenser	60,000 gal. per min. each, alone 100,000 gal. per min. both together
Drive	325-hp., d.c., 240-v., General Electric motor, 255 to 175 r.p.m.
Rotative dry vacuum pumps, 30x18-in. vert.	Laidlaw Dunn-Gordon, feather valve
Drive	66-hp., d.c., 240-v., General Electric motor, 120 to 60 r.p.m.
Hotwell pumps	Combined with boiler-feed pumps

AUXILIARY TURBO-GENERATORS, DIRECT CURRENT

Two-unit, 4,000 kw., direct-current machines	3
Turbines, multi-stage; compound high press., 11 stages; low-press., 8	DeLaval Steam Turbine Co.
Reduction gears, 85 in. pitch diam., face 36 in., h.p. pinion 7.8 in. diam., l.p. pinion 10.2 in. diam.; speed h.p., 4,000 r.p.m.; l.p. 3,000 r.p.m.	DeLaval Steam Turbine Co.
Operating conditions, steam extraction between high- and low-pressure turbines or from seventh stage of h.p. turbine	
Steam conditions	390-lb. gage, 700 deg. F., exhaust 1.5 in. mercury abs.
Generators, 4,000-kw., d.c., 250-v., 360 r.p.m.	General Electric Co.
Condensers, two-pass surface, 7,500 sq.ft.	Worthington Pump & Mach. Corp.
Circulating pumps, three volute, gal. per min	10,000
Drive	60-hp., d.c., 240-v., General Electric motor, 435 to 215 r.p.m.
Rotative dry vacuum pumps, 3 hor. 21x14-in.	Laidlaw-Dunn-Gordon
Drive	25-hp., d.c., 240-v., General Electric motor, 125 to 60 r.p.m.
Hotwell pumps, three two-stage, gal per min.	150
Drive	30-hp., d.c., 240-v., General Electric motor, 1,600 to 1,200 r.p.m.

Guaranteed performance with no bleeding:

Kilowatts	6,000	4,000	3,000	2,000
Lb. steam per kw.-hr.	10.93	10.72	11.05	11.56

AUXILIARY TURBO-GENERATORS, ALTERNATING CURRENT

Two units, 2,000 kw. at 66 per cent p.f.	Westinghouse Electric & Mfg. Co.
Turbine, 12-stage, parallel flow, extraction at 5 lb. gage	
Steam conditions	385 lb., 255 deg. F. superheat
Generators	3-phase, 60-cycle, 2,300-volt, 3,600 r.p.m.
Condensers, two-pass surface, 4,100 sq.ft.	Worthington Pump & Mach. Corp.
Circulating pumps, two volute, gal. per min.	8,000
Drive	60-hp., a.c., 220-v., General Electric motor, 720 to 450 r.p.m.
Vacuum pumps, four No. 6 hydraulic	Worthington
Supply pumps for hydraulic vac. pumps, two, gal. per min.	1,000
Drive	25-hp., a.c., 220-v., General Electric motor, 1,800 r.p.m.
Hotwell pumps, two, gal. per min.	80
Drive	15-hp., a.c., 220-v., General Electric motor, 1,800 r.p.m.

Guaranteed performance with no bleeding:

Kw. at 66 per cent power factor	1,200	1,600	2,000
Lb. steam per kw.-hr.	12.7	11.8	12.3

MISCELLANEOUS MECHANICAL EQUIPMENT

Air compressor, one two-stage, 825-cu.ft. per min., 125-lb.	Bury Compressor Co.
Traveling water screens, six, inclined	Chain Belt Co.
Turbine-room crane 125-ton	Whiting Corp.
Storage tanks, eight, 23,500 gal. each	Muskegon Boiler Works
Oil purifiers, centrifugal	DeLaval Oil Separator Co.
Oil-circulating pumps	Connersville Blower Co.
Pumps for transformer oil	Connersville Blower Co.
Sump pumps	Kerr Machinery Co.
Vacuum pumps, heating system	Nash Engineering Co.
Steam traps	J. Hopkinson & Co., Ltd.
Water columns	Kitts Steam Specialty Co.

PIPING, VALVES AND COVERING

High-pressure steam piping and fittings	Crane Co.
Circulating water piping	Worthington Pump & Mach. Corp.
Pipe joints	Vanstone
Pipe covering, 4 in. 85 per cent magnesia	
Non-return valves	Schütte & Koerting Co.
High-pressure steam gate valves	J. Hopkinson & Co., Ltd.
Motor-operating equipment for gate valves	Payne Dean, Ltd.
Low-pressure steam and water valves	Crane Co. and Chapman Valve Manufacturing Co.
Gate valves, circ. lines	Hydraulically operated, Chapman
Boiler-feed, gate, globe and check valves	Chapman and Lunkenheimer
Atmospheric relief valves	Davis Regulator Co.
Blowoff valves	J. Hopkinson & Co., Ltd.
Safety valves (Consolidated)	Manning, Maxwell & Moore

INDICATING AND RECORDING INSTRUMENTS

Boiler meters, air flow, steam flow	Bailey Meter Co.
Steam-flow meters, electric	General Electric Co.
Water meters, venturi	Builders Iron Foundry
Indicating pressure gages	Foxboro Co.
Recording pressure gages	Foxboro Co.
Recording thermometers	Foxboro Co.
Draft gages, multi-pointer	Bailey Meter Co.
Warren clocks	General Electric Co.

ELECTRICAL EQUIPMENT

Switchboard instruments	General Electric Co.
Transformers, oil switches, lightning arresters and electrical equipment generally	General Electric Co.

Computing Guaranteed Stoker Efficiency

By H. F. GAUSS
Chief Engineer, Illinois Stoker Co.

In a previous article (May 20 issue) consideration was given to the amount of air required for combustion and the temperature of the escaping gases. In the present article other items pertaining to the subject, such as unaccountable losses, moisture in the coal, available hydrogen content and combustible matter in the ash are given attention.

THE loss from the furnace and setting due to radiation, heat in the ashes dumped into the ashpit, heat loss in blowing down the boiler, etc., is often referred to as the "unaccountable loss," owing to the difficulty in computing what its exact amount will be. It is assumed commonly that the temperature of the flue gases as they leave the boiler indicate what

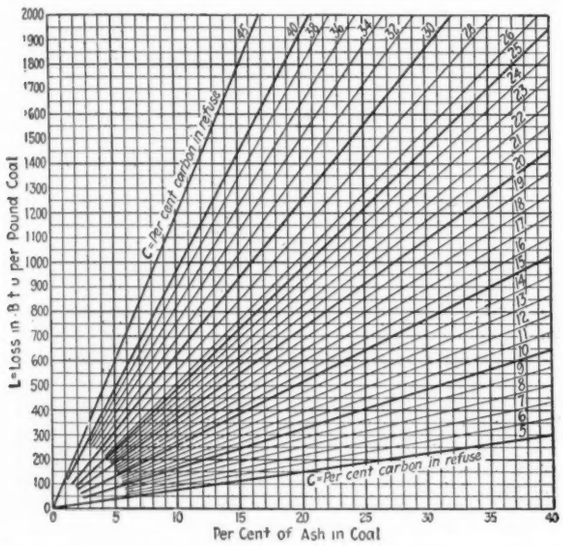


Fig. 1.—Heat loss due to unburned carbon in the ash

the boiler is doing, and the conclusion is drawn that when this temperature is low, the boiler is successfully absorbing the heat generated in the furnace. This assumption may or may not be true, however, as the radiation loss has a decided effect on flue-gas temperatures. The temperature within the setting, the shape and size of the setting, the thickness of the walls and the thoroughness of the insulation, are factors largely determining the amount of loss due to radiation, and unless all these factors are known there is much uncertainty in arriving at the exact amount of this loss, and consequently at what the boiler itself is really doing.

The heat loss due to dumping hot ashes into the ashpit and due to blowing down the boiler at intervals is indeterminate, but should easily be kept within 4 per cent of the heat in the fuel supplied.

The accompanying table gives the various unaccountable losses included in Item 2 of the previous article and stated as a percentage of the total heat in the fuel as fired.

To illustrate the use of this table, let it be required to know the unaccountable loss incurred when burning coal containing 12,000 B.t.u. in a furnace having ordinary firebrick walls backed with red brick, with the

UNACCOUNTABLE LOSSES IN PER CENT OF HEAT IN FUEL AS FIRED

Ordinary firebrick backed with red brick

Cause	Per Cent of Normal Boiler Rating 100	150	200	250	300
Radiation	3	3½	4	4½	5
Hot ashes	1	1½	2	2½	3
Blowing down and leaks	1	1	1	1	1
Total	5	6	7	8	9
Insulated Setting					
Radiation	1	1½	2	2½	3
Hot ashes	1	1½	2	2½	3
Blowing down and leaks	1	1	1	1	1
Total	3	4	5	6	7

boiler operated at 200 per cent rating. From the table the total loss will be 7 per cent of 12,000, or 840 B.t.u.

The loss due to moisture in the coal is the next item for consideration. This loss results from the fact that the moisture passes out as superheated steam with the flue gases. It is easy to compute the heat thus lost as follows, considering the pressure in the furnace as 14.7 lb. abs.:

$$L_m = [1{,}112 + 0.48(T_f - 212)] \times \textit{percentage of moisture}$$

where

L_m = Heat carried away by the moisture in the form of superheated steam;
1,112 = (212 — 70) + 970 = total heat in dry saturated steam above 70 deg. F.;
0.48 = Specific heat of superheated steam at atmospheric pressure;
T_f = Temperature of the flue gases;
$(T_f - 212)$ = Superheat.

To illustrate the application of this equation, suppose the fuel to contain 5 per cent moisture and the gases leave the boiler at 550 deg. F. Then the loss due to moisture is

$$L_m = [1{,}112 + 0.48(550 - 212)]0.05 = 64 \textit{ B.t.u.}$$

The loss due to the available hydrogen in the fuel is determined in a manner similar to that for finding the loss due to moisture. By available hydrogen is meant the hydrogen not already combined with oxygen in the form of water. In making an ultimate analysis of the fuel, the chemist breaks up any water present into hydrogen and oxygen. He measures the free oxygen thus formed and the hydrogen. With this hydrogen, however, he also measures any additional hydrogen free or combined with other elements. This additional or available hydrogen burns to water in the furnace and is then carried up the stack in the form of superheated steam. Since oxygen and hydrogen combine in the

proportion by volume of 2 of hydrogen to 1 of oxygen, and since oxygen is 16 times as heavy as hydrogen, it follows that the hydrogen necessary to unite with a given volume of oxygen and form water, will weigh one-eighth as much as the oxygen. Knowing from the analysis the total hydrogen and oxygen, it is a simple matter to determine the available hydrogen by subtracting from the total hydrogen one-eighth of the oxygen, or $H_a = H - \frac{O}{8}$, where H_a = available hydrogen in pounds per pound of fuel; H = Total hydrogen in pounds per pound of fuel, and O = Total oxygen in pounds per pound of fuel. Since we are dealing with one pound, all percentages are nominally fractions of one pound.

During the process of combustion, as the available hydrogen combines with oxygen from the air and burns to water, heat is generated which is included in the heat value of the coal, but the highly superheated steam formed escapes with the flue gases, carrying away the heat in it above 70 deg. F. The amount of this heat in B.t.u. may be computed by means of the following formula:

$$L_h = (H_a + 8H_a)\ [1{,}112 + 0.48\ (T_f - 212)]$$

where

L_h = Loss in B.t.u. due to available hydrogen;
H_a = Weight of available hydrogen per pound of fuel;
$8H_a$ = Oxygen necessary to combine with H_a to form water;
$(H_a + 8H_a)$ = Weight of water formed;
1,112 = Heat in dry saturated steam above 70 deg. F.;
0.48 = Specific heat of superheated steam at atmospheric pressure;
T_f = Temperature of the flue gases;
$(T_f - 212)$ = Superheat.

Thus, if the fuel contains 3 per cent hydrogen and 8 per cent oxygen, the available hydrogen per pound is:

$$H_a = 0.03 - \frac{0.08}{8} = 0.02 \text{ lb. per pound of fuel,}$$

so that

$$L_h = (0.02 + 8 \times 0.02)\ [1{,}112 + 0.48\ (T_f - 212)] = 0.18 \times 1{,}274 = 229 \text{ B.t.u.}$$

The remaining condition predetermining the efficiency possible is the percentage of unburned fuel in the ash. There will always be some loss due to this cause, depending largely upon the character of the fuel, the rate at which it must be burned, the length of time it remains in the furnace and of course the design of the stoker. It is generally assumed that the combustible in the refuse is pure carbon inasmuch as the volatile and other elements in all probability will be consumed during their trip through the hot furnace. The heat value per pound of combustible in the refuse is therefore 14,600 B.t.u. The loss due to combustible in the refuse may be found by means of the formula,

$$L_c = \frac{c}{1 - c} \times A \times 14{,}600$$

where

L_c = Loss per pound of fuel due to combustible in ash;
A = Weight of ash per pound of fuel;
c = Fraction of combustible in refuse.

To complete the illustration, assume that the fuel contains 15 per cent ash and that the carbon in the refuse is 10 per cent. Then

$$L_c = \left(\frac{0.10}{1 - 0.10}\right) 0.15 \times 14{,}600 = 0.111 \times 0.15 \times 14{,}600 = 243 \text{ B.t.u.}$$

It might be well to recapitulate the various formulas developed for finding the losses which predetermine the efficiency. They are as follows:

Stack loss = $L_s = (T_f - 70)\ (A_a + C)\ 0.24$;

Unaccountable loss = L_u is commonly expressed as a certain percentage of the heat in the coal;

Loss due moisture = $L_m = 1{,}112 + 0.48\ (T_f - 212) \times$ per cent moisture;

Loss due available hydrogen = $L_h = (H_a + 8H_a)\ [1{,}112 + 0.48\ (T_f - 212)]$;

Loss due combustible in ash = $L_c = \frac{c}{1 - c} \times A \times 14{,}600$.

C = combustible in fuel; c = combustible in refuse.

The total loss then is the sum of all, or $L_s + L_u + L_m + L_h + L_c$. It follows that the heat per pound of fuel which will be absorbed by the boiler must be the heat per pound of fuel minus the total heat lost, and the efficiency will be the heat absorbed by the total heat, or

$$\text{Efficiency} = \frac{H - (L_s + L_u + L_m + L_h + L_c)}{H}$$

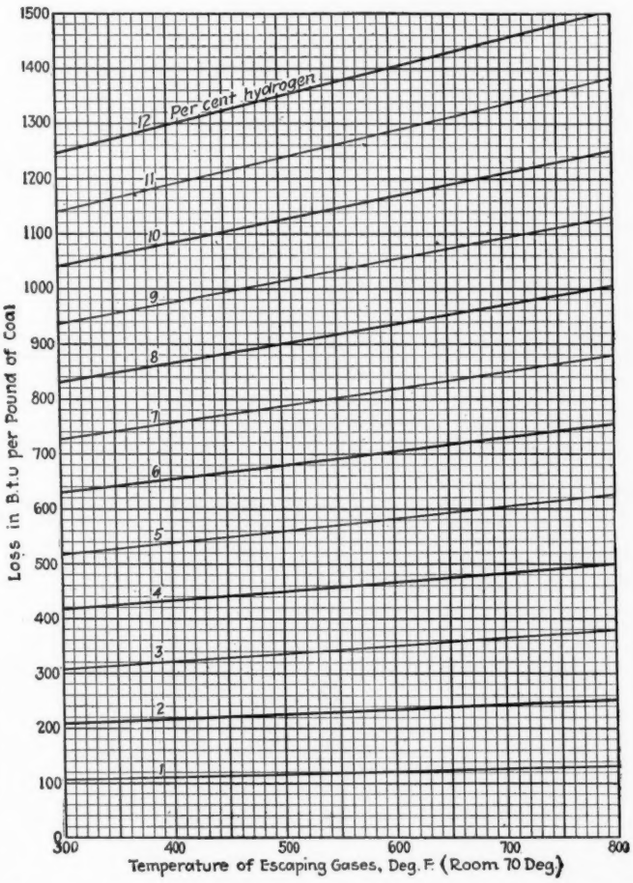


Fig. 2.—Heat loss due to available hydrogen in the fuel

The illustration used to demonstrate each step of the method is stated collectively in the following: The fuel to be burned was bituminous screenings having

80 per cent combustible, 5 per cent moisture, 15 per cent ash and 12,000 B.t.u. per lb. The available hydrogen was 2 per cent; the CO_2 in the products of combustion, 12 per cent; the temperature of the flue gases, 550 deg.; and the combustible in the refuse, 10 per cent. Then

	B.T.U.
$L_s = (550 - 70)\ (14.63 + 0.8)\ 0.24$	1,777
$L_u = 0.07 \times 12{,}000$	840
$L_m = [1{,}112 + 0.48\ (550 - 212)]\ 0.05$	64
$L_h = (0.02 + 8 \times 0.02)\ [1{,}112 + 0.48\ (550 - 212)]$	229
$L_c = \frac{0.1}{1 - 0.1}\ 0.15 \times 14{,}600$	243
Total loss	3,153

The heat that will be absorbed by the boiler must be 12,000 — 3,153 = 8,847 B.t.u. and the efficiency that

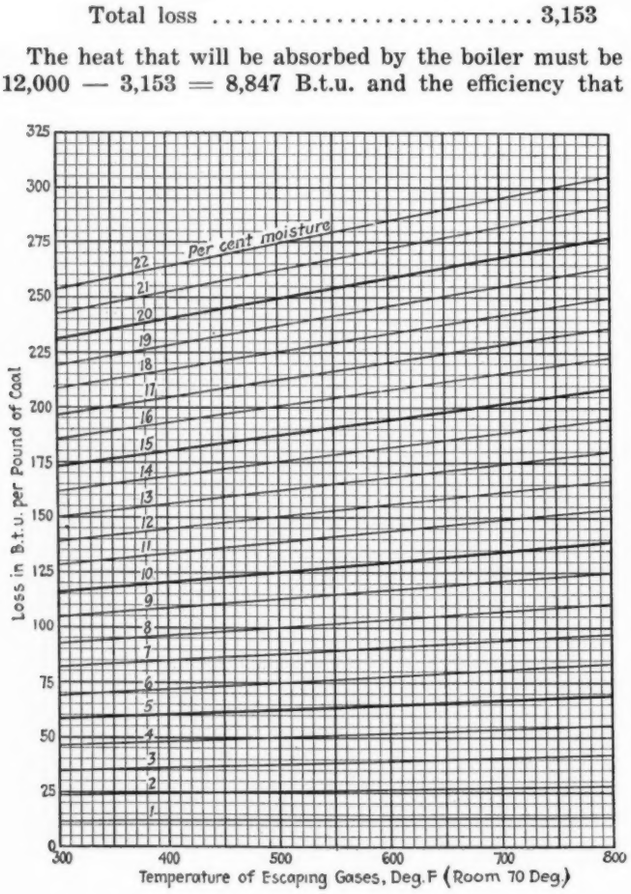


Fig. 3.—Heat loss from moisture in the fuel

can be definitely guaranteed will be 8,847 ÷ 12,000 = 73.7 per cent.

To facilitate actual substitution in the various formulas, a graphical method is often resorted to, and the accompanying charts have been designed for this purpose. Their use is self-evident. The method outlined is not only of value in determining the highest efficiency that may be guaranteed, but is valuable also in analyzing the results of a test and finding if possible what changes may improve the efficiency obtained and whether or not such changes will pay.

In using any method of the kind just developed, the designer must bear in mind certain principles. First, it may be that the fuel specified contains ash of such a low fusing point that the clinker formed will interfere with the air distribution to such an extent that the fuel cannot be burned as efficiently as its other characteristics might indicate. Second, the fuel may contain such an amount of finely powdered dust that the pressure necessary to force the air through the fuel bed must be so high that the fuel bed is disturbed in spots, becoming uneven and full of holes, so that more excess air than otherwise necessary is admitted. Third, the sizing of the fuel to be burned may not be uniform, resulting in portions of the grate receiving coarse fuel and other portions fine fuel, thus giving rise to poor air distribution and low CO_2. Many other conditions could be enumerated, all of which are familiar to the experienced designer. The matter can be summed up by stating that no method can be used blindly without due consideration of all factors involved. Also, it will be well to bear in mind that an efficiency obtained by a stoker when burning a certain fuel, should not be used as an index to what the stoker is capable of, in general, until the fuel characteristics are all known.

Alternating Current Converted into Direct Current at 100,000 Volts

Among the electrical equipment shown at the British Empire Exhibition, Wembley, England, is a machine known as a "Transverter," which is being exhibited for the first time by the English Electric Co. This machine, according to *Engineering*, London, is rated at 2,000 kw. and is designed to convert three-phase 50-cycle 6,600-volt alternating current into direct current at 100,000 volts for transmission. At the receiving end of the transmission line a similar device may be used to convert the high-voltage direct current into alternating current at distribution voltages. In the stepping-down process not only can the voltage be changed, but the machine can be designed to deliver the alternating current at any desired frequency. For example, 6,600-volt 25-cycle alternating current can be stepped up to 100,000-volt direct current and at the receiving end stepped down to 2,300-volt 60-cycle alternating current.

The machine may be considered a combination static transformer and rotary converter, and it is from this that it gets its name "Transverter." Two of these experimental units have been built, one of 250-kw. and another of 2,000-kw. capacity. The 250-kw. unit comprises six three-phase transformers or the equivalent of 18 single-phase units. Each leg of the transformer core carries two secondary coils, one of which is connected in reverse to the other. The result is that the secondary current consists of 36 distinct phases, evenly spaced in time with a phase displacement of 10 electrical degrees. This secondary consists of 2,296 sections of 30 turns each to give 100,000 volts at the terminals of the machine. These 2,296 sections are connected to the same number of bars in eight stationary commutators of the disk type. Conversion into direct current is obtained by driving the brushes resting on the commutators by a synchronous motor supplied with power from the alternating-current system; thus the brushes have a speed corresponding to the frequency of the supply system. A synchronous motor considerably larger than required for driving the brushes is used, and the excess capacity utilized for power-factor correction. The transformers are oil insulated as in the standard types and are mounted on a bedplate along with the commutators and brush-driving motor.

A Visit to the Carels Works at Ghent

Diesel Engines for South America—Notable Steam-Engine Work—Production

BY G. L. CARDEN

THE rapid recovery of Belgian industries after the war is astonishing to those who are unacquainted with the resourcefulness of this people. The rapidity with which the plants destroyed or rifled by the invading army were re-established is best revealed by a visit to some of the leading machine builders.

The Carels Works in Ghent were seized by the Germans early in the war, and the shop organization having refused to undertake any work for the enemy, a complete German staff took over the shops, and up to the almost last day of fighting the plant was used as an artillery reconstruction works. When the outcome of the war was foreseen, all the usable machine tools and foundry equipment were hurried across to Germany.

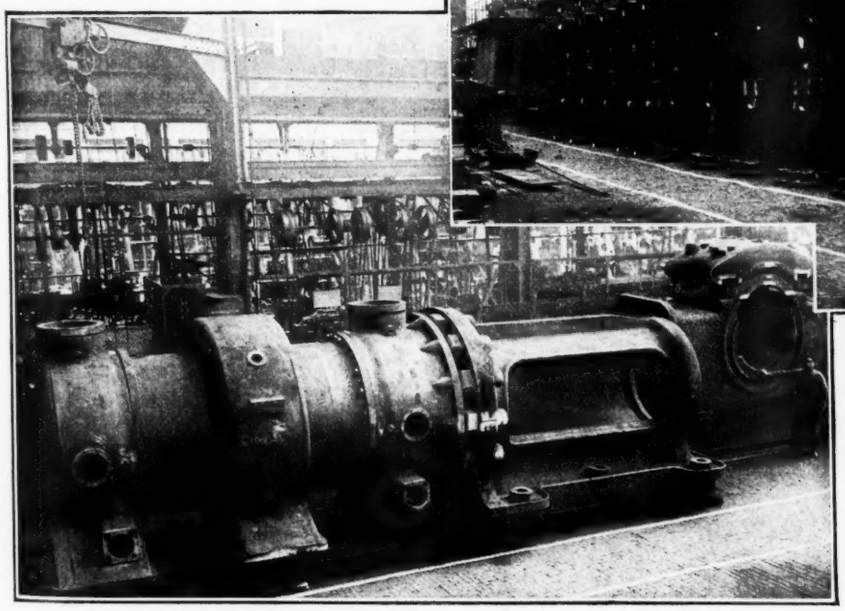


Fig. 2—4,000-horsepower Carels unaflow engine

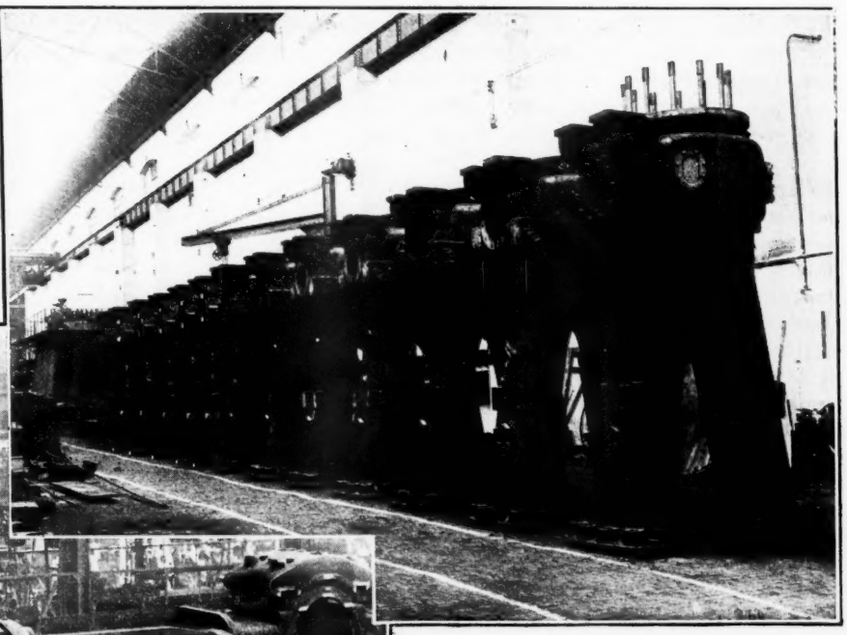


Fig. 1—Diesel engine frames awaiting erection

For the purpose of seeing what changes had taken place since the war, I visited the Carels a short time ago. I have known the works in pre-war days when as a special agent of the Department of Commerce I had made detail reports on the equipment and output to Washington. I found that not over 5 per cent of the machinery taken by the Germans had been returned, and the shops had been completely refurnished with the most up-to-date tools, in many ways superior to the machinery lost to the Germans, since much of the latter was obsolete in design. The works are also much enlarged and, while formerly but 650 men were employed, Carels now carry 1,750 persons on the payroll. Locomotive building, which was carried out in the old days, has been discontinued, and the attention of the heavy machinery departments is confined exclusively to Diesel and steam-engine construction for stationary service.

To round out the list of products, an electrical department has been created, in which is built a fairly large line of generators, motors and transformers. The Thomson-Houston interests in Paris effected a combination with the Ghent shops shortly before the Armistice and are responsible for the addition of the electrical undertaking.

The Carels were pioneers in Diesel-engine construction and have developed this type for both four-stroke and two-stroke cycles. The firm, while constructing many small four-stroke-cycle Diesels, build units of 1,000 hp. and over on the two-stroke-cycle principle. They state that the fuel and lubrication oil consumptions compare favorably with records of units operating on the four-stroke cycle. The largest units so far built have been 2,000-hp. four-cylinder units, but the company is prepared to go much higher in the size range.

Passing through the erecting shops, I observed five four-stroke-cycle A-frame Diesels. There were also a series of 13 frames which were to make up 1,500-hp. units ordered by the Societe Morocaine, Casablanca, Morocco, Africa. Orders for five 750-hp. units are on hand from Argentina. I was informed that Carels have built and just delivered a number of Diesels for South America. They were of 500 and 750 hp. each and were to be installed in sets of two in a number of lighting stations. In addition to the orders mentioned, the company has been called upon to furnish Diesels for installations in France, Africa, India and Poland.

The Carels engineers state that it is a growing practice to install oil engines in plants where water turbines are employed and when the maximum power can be obtained for only a part of the year or when the peak load is beyond the hydraulic capacity. Diesel engines held in reserve can be brought into service as soon as the water falls below an effective working level. Here comes in the great advantage possessed by the oil engine of being able to go into service without a minute's delay.

It was a distinguished American engineer who declared, after inspecting all the steam engines on exhibit at the Paris Exposition, that in his opinion the best units displayed were from Carels of Ghent, Sulzer of Winterthur, and Tosi of Legnano. Carels showed a 1,000-hp. cross-compound engine, and today in the Carels shops there is in the power plant an engine that has been running for 40 years. It has been a specialty of Carels to build machines for continuous non-stop service.

Carels justly came into high repute through their development of engines using superheated steam. They were certainly the first in this development in Belgium, having taken the subject up at Earl in 1897. They guarantee for their superheated steam engine 9¼ lb. of steam per indicated horsepower-hour for compound engines. It has been found possible to work with temperatures of 660 deg. F. and higher, the steam consumption varying from 9½ to 11 lb. at 135 lb. gage, according to the size of the engine.

The Carels unaflow engine gives a steam consumption of 11.4 lb. per indicated horsepower at 465 deg. F., 9.69 lb. at 575 deg. F. and 9.36 lb. at 665 deg. F. In the unaflow engine the Carels have retained the drop gear for the inlet valves. They maintain that this obviates steam lamination, reduces wear and tear of working parts and leaves to the governor a full range of sensitiveness.

I observed a single cylinder casting for a 4,000-hp. unaflow engine, declared to be the largest unit of the type built in Europe. The casting of the frame and cylinder as it came out of the mold was approximately 38 tons working down finally in the machine to about 25 tons.

Sawdust as a Fuel for Gas Production

By Harrold Dormand

Much has been written about wood waste as a fuel for gas production, but no writer has devoted much attention to sawdust. Sawdust is a refuse separated from other wood waste in sawmills by the fact that it is sucked directly from the saws by the blowers, and this great byproduct of the lumber industry presents many difficulties as to its final distribution and destruction.

It is a well-known fact that the burning of sawdust under boilers is not an unqualified success, since it forms an impervious layer on the fire grate, with the result that complete combustion is impossible unless the sawdust be mixed with another highly combustible and loosely packed fuel. Much experimenting has been done on the carbonization and briquetting of sawdust, but this process is costly.

By its partial destruction sawdust, like the wood it comes from, is productive of gases useful to industry, but of the many designs of wood-waste gas producers, not one can be called a success when used with sawdust only or like refuse. Rapid combustion during the gasifying period and heavy distillation are the chief causes of the inconsistency of these generators.

Fuels of the nature of sawdust, being in so finely divided particles, can be successfully gasified only by use of the suction principle, for the fuel bed cannot be agitated in any other way. Intermittent suction is the most successful, for the short period between each suction stroke allows the fuel to settle down again.

By far the most important feature of the gas generator is the method of feeding the sawdust into the generator, so as to be able to supply a continuous and adequate flow of fuel as required by the call of the suction stroke, replacing on each suction stroke the fuel gasified and keeping the bed of fuel in the generator in motion. No holes should be allowed to form in the fuel bed, and the fresh fuel in the uppermost zone of the combustion should give sufficient resistance to the outgoing gases to prevent any partly carbonized fuel being drawn off with the gases.

Another feature demanding attention, is the means whereby the zones of combustion can be arrested at will and not allowed to creep higher and higher in the generator, as is prevalent in the present type of

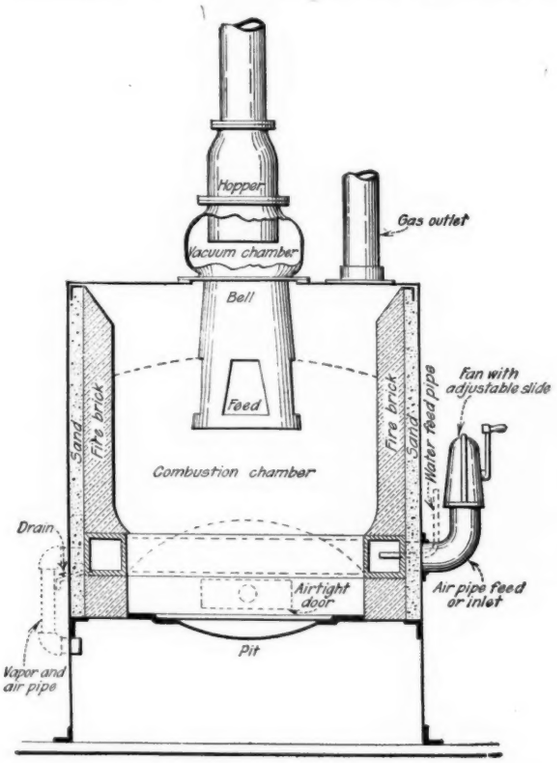


Fig. 1—Cross-section of sawdust gas producer

wood-refuse producers where only air is used to support combustion. It is admitted that, owing to the high percentage of distillate matter in wood, the higher the temperatures reached during combustion the better chance one has of burning some of the products of distillation into fixed gases, but it is useless to go the limit in this respect. When using high temperatures, no zones of combustion can be maintained and the rate of distillation rises with the temperature. The combustion eventually reaches such a height that the fuel

bed offers no resistance to the outgoing gases, and as a result ash and partly carbonized fuel are drawn off with the gases, choking up the pipes to the scrubbers and eventually causing stoppage.

Many years of experimenting led to the design of the suction-gas producer shown in Fig. 1, which will successfully gasify sawdust and like refuse, working automatically, without poking or interfering with the

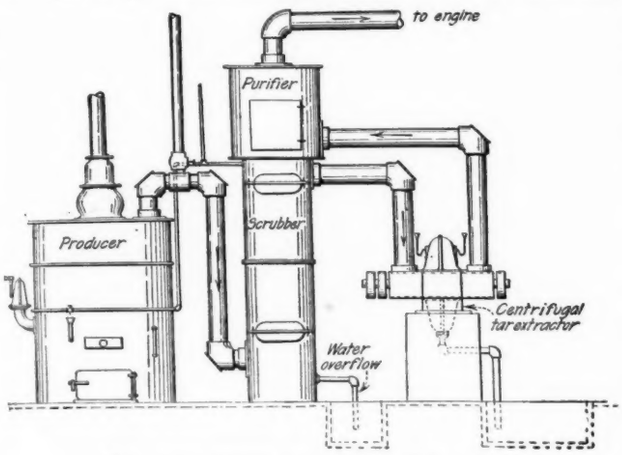


Fig. 2—General outline of the entire gas-making machinery

combustion, producing good and clean power gases, without any dust or partly carbonized fuel being drawn off the gases.

The generator is constructed in the usual way, outer steel casing, firebrick lining, fire grate of loose bars with ashpit below, all sealed from the atmosphere. The fuel is fed into a feed bell, at the lower extremity of which are several feed openings. The gravitation on this whole column, for the storage hopper is aways maintained full, forces the fuel through these openings, while feeding the center of combustion at the same time. By these means the suction area—that is, the space around the feed bell—is adequately fed with fresh fuel evenly distributed and proportionate to the demand, giving an equal resistance to the volatile gases leaving the combustion and allowing no holes or weakness to form in the fuel bed. At the lower part of the storage hopper is placed a vacuum chamber, which stays the movement of the fuel momentarily, preventing unnecessary fuel being dumped into the generator.

The openings in the feed bell, together with the vacuum chamber of the storage hopper, work automatically with the suction stroke on the generator, doing away with all poking and interfering with the combustion, by keeping the fuel in motion. When the suction stroke caused by the action of a gas-engine piston or other device, reaches the upper part of the generator, this part is immediately filled with gas and at the same time the whole body of fuel in the generator, being light in weight, is lifted, until the vacuum chamber above the fuel is filled with gas, and then, according to the laws of gravitation, the fuel falls again, forcing the ash in the lowest zone of combustion through the firebars. After each fall and as the fuel bed settles down with its own weight, the feed openings replenish the suction area with fresh fuel.

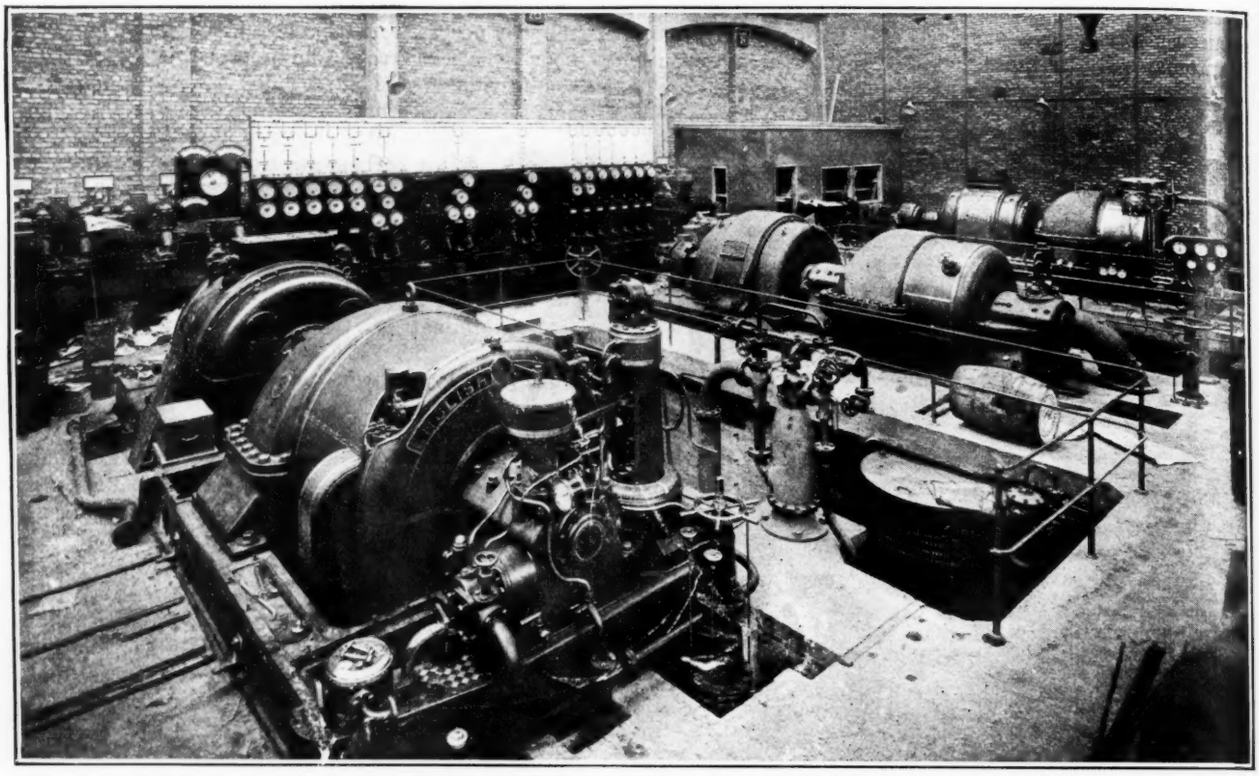
Contrary to the convictions of many designers, it has been found that wood refuse can be given all the water vapor it can comfortably decompose without producing an excess of hydrogen sufficient to cause premature ignition in a gas-engine cylinder, but this is not advisable. Only sufficient vapor should be used to arrest the combustion zone and keep it from climbing too high in the generator, and enough vapor for this purpose can be raised by the heat of combustion, in the producer. With this end in view, at a given height above the fire grate and exposed to the heat of the combustion zone, is an annular ring or vaporizer chamber, into which water is admitted in variable quantities. The vapor generated in this chamber, together with the air needed for gasification, is sucked into the producer by way of the ashpit, and the heat of the burning mass regulates the amount of vapor produced. Arresting the combustion in this way is more beneficial than one would imagine, for the cooling effect contracts the fuel bed and allows no fusing to take place and also minimizes the production of tarry products of distillation. The fire need only be withdrawn after long periods of working and then only to examine the firebrick lining.

In other designs of wood-waste producers the feed bell is called the distilling chamber, but how and where the products of distillation find an outlet it is hard to understand. No distillation could take place there, for no fuel would remain there long enough to distill. The only trouble I have ever experienced with the fuel in the feed bell is, that on rare occasions the fuel is liable to have an excess of moisture and to swell to a point of sticking. To obviate this possible disadvantage, a poker hole is made in the outer top cover, running diagonally through the bell to each aperture. These poker holes, being sealed with fuel, will not allow any air to be sucked into the generator when opened, so there is no possibility of altering the stability of the gases. The moisture in the fuel does not in any way help to enrich the gases, but has a damping effect on the uppermost zone.

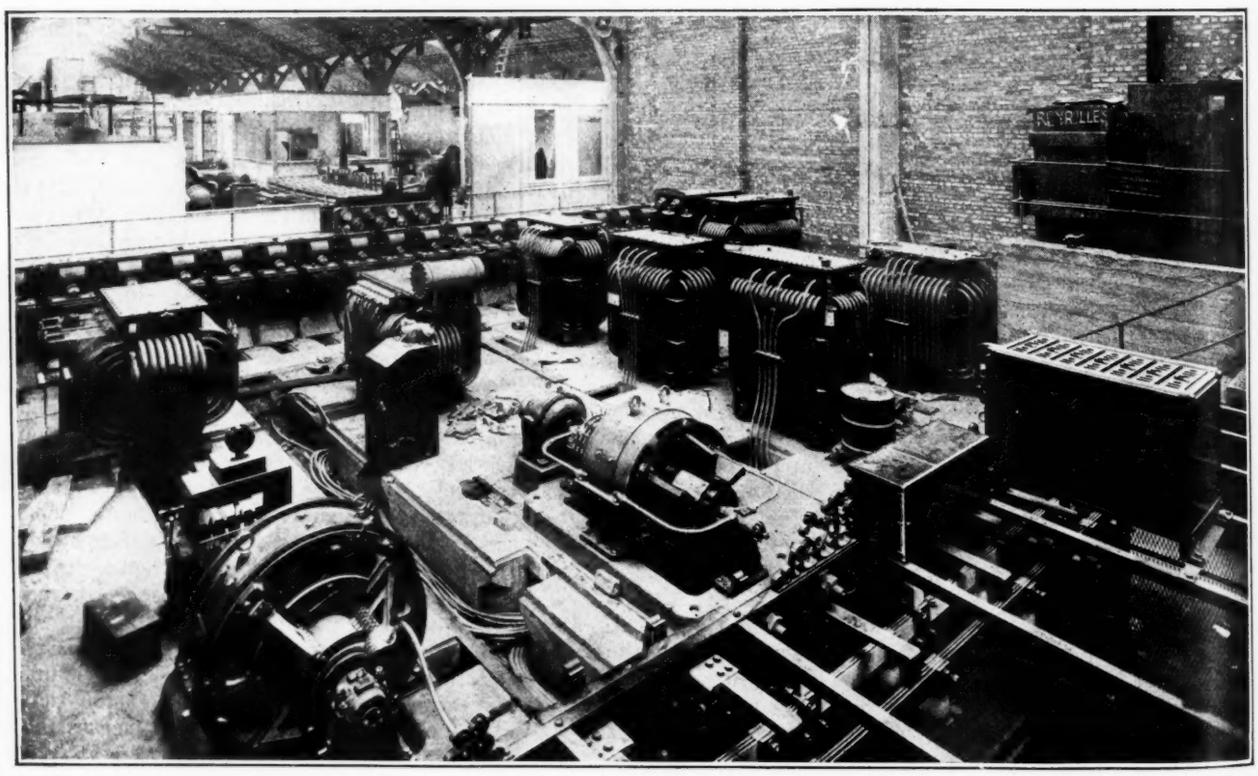
The generator has been installed in a lumber mill and is worked for ten consecutive hours without stoppage and a continuous supply of good and clean power gases is produced with a minimum of distillation. The fuel consumption of the engine using the gas never exceeds two pounds an hour. The fuel bed was withdrawn after two months' working and very little carbonized fuel was found adhering to the firebrick lining. The fuel consists of spruce and birch sawdust with 18 per cent moisture.

The magnetic method of separating carbon from ash depends upon the property of magnetism possessed by the ash, due to the iron oxide it contains. The iron oxide is the product of the combustion of iron pyrites, of which all coals contain more or less. Neither unburnt coal nor coke cinders are magnetic, so that suitably designed magnetic drums rapidly effect a separation. Dry ash is necessary, and large sized ashes cannot be very successfully treated by this method. On the other hand, all the combustible matter is recovered, and in the dry state. It has been found possible in many cases to recover from ash as much as 6 per cent of the fuel burned, although figures of this magnitude would apparently indicate some inefficiency of the combustion chamber or of the air admission. In many cases, however, the recovery is said to be sufficiently great to show a profit upon the plant required.—*Beama.*

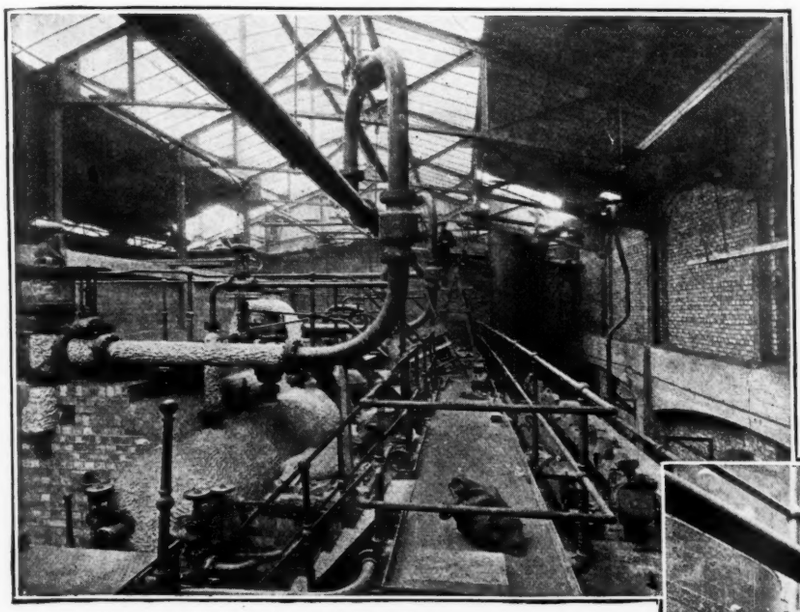
Views in Power House of



Above: Turbine room, containing three 1,500-kw. units. Below: Substation, containing transformers and rotary converters

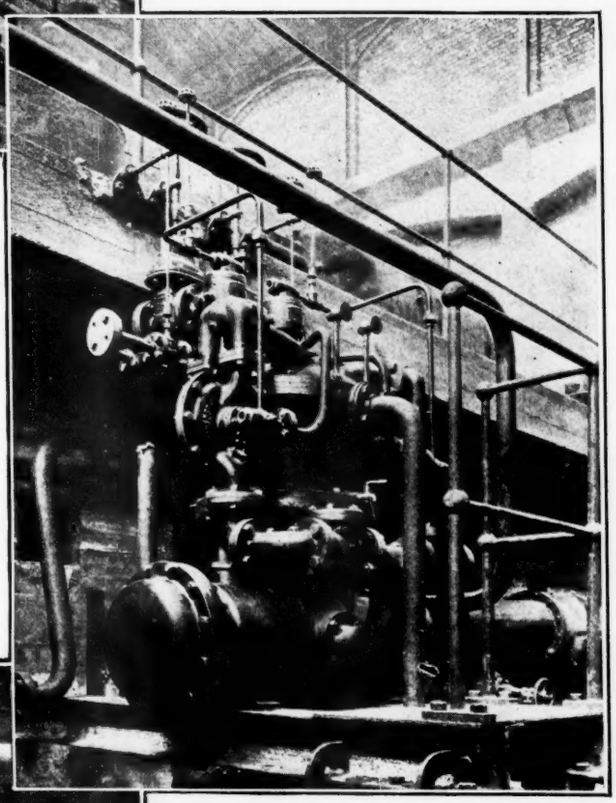


British Empire Exposition

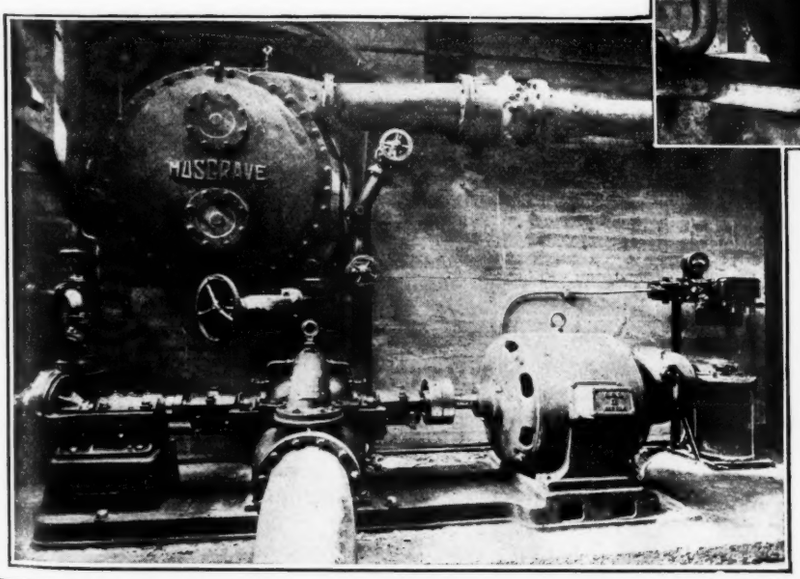


Left: Looking over boiler drums

Below: Radojet air extractor



The total requirements of the exposition are about 4,500 kw., supplied by three 1,500-kw. turbo-generators, four reciprocating units aggregating 1,000 kw. and 2,000 kw. purchased. Steam is generated at 220 lb., 600 deg. in four water-tube boilers.



Left: Circulating and condensate pumps

Photos by Campbell Gray

Reconnecting Direct-Current Armatures —Types of Armature Coils

By A. C. ROE

THE armatures in modern direct-current motors and generators are mostly wound with diamond-shaped two-layer pulled-type coils, although some of the early types of armatures used mold-wound coils of different shapes. Fig. 1 shows a type of wire coil that is wound on a mold to shape and uses one type

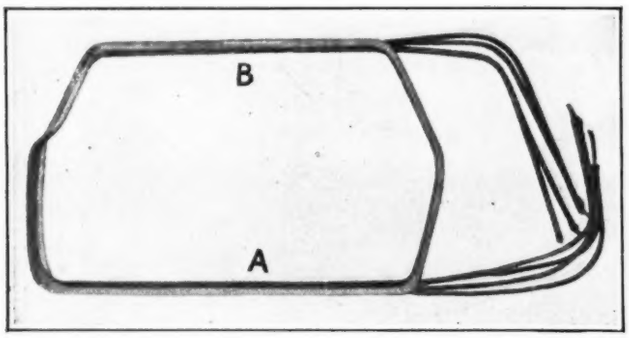


Fig. 1—Half-diamond and half-involute type of coil

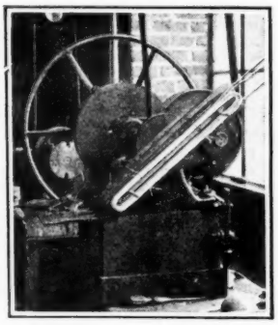


Fig. 3—Pull-type coil on winding shuttle

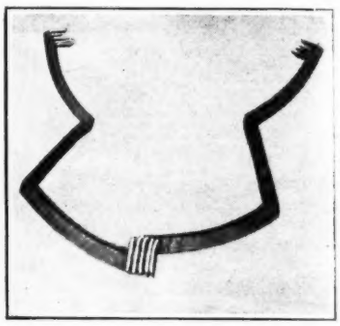


Fig. 4—Strap-copper coil for wave winding

range of motors. This coil is what is known as half diamond and half involute. The figure shows a plan view; that is, looking down on the coil. The longest side *A* is the top half and the short side *B* the bottom half. The coils are so shaped as to allow them to nest into a two-layer winding. This type of coil is wound in two sections, which are then hot-pressed together to form a group of two coils, each consisting of two turns of two No. 8 double cotton-covered wires in parallel, making four leads to a side as shown. The leads are on the bottom of the coil. The top leads are brought out between the coils to the commutator, and the bottom leads bend down under the winding out of the way. This type of coil requires an expensive mold, as the coils are wound to the exact and final shape. As there are two single coils taped together, for an armature having 47 slots and 93 commutator bars there would have to be 94 single coils. These would then be assembled and pressed together. A 0.005-in. or 0.003-in. paper cell is glued to the slot section of the coils while winding. The cotton covering on the leads is also put on while winding and fastened under the paper cells. After being pressed, the coils are dipped in an insulating varnish and baked, after which 1½ turns of treated-cloth wrapper is put on the slot section and the whole coil taped with one layer of 0.007-in. thick by ¾-in. wide cotton tape. This tape is half overlapped on the ends and butted on the cell section. After being taped, the coil is again dipped in an insulating varnish and baked.

Fig. 2 shows another type of mold-wound coil. This was used on a type range of direct-current machines and requires less room at the end of the armature than the coil, Fig. 1. Fig. 2 indicates the way the coils nest together. This type of coil is wound with the leads on top, which requires that the bottom leads be bent down and the top leads come out over the ends. This coil requires the same expensive mold and the expenditure of the same amount of labor as the type Fig. 1.

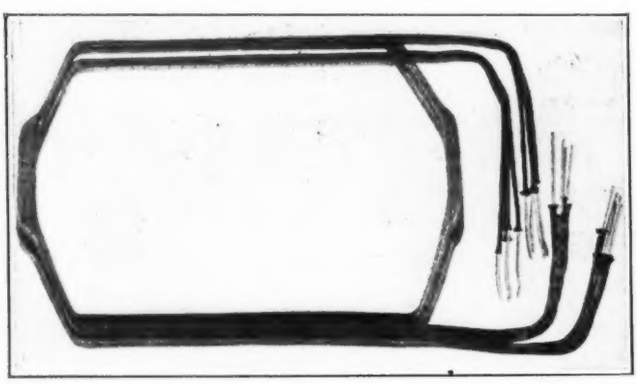


Fig. 2.—Shows how two mold-wound coils nest together

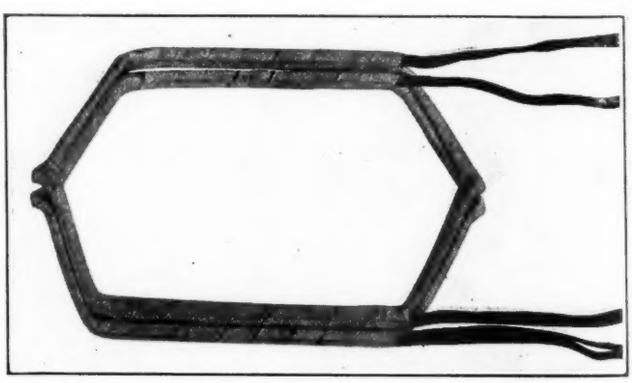


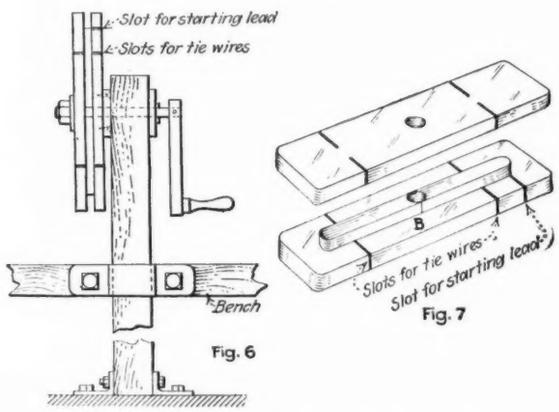
Fig. 5.—Two diamond-shaped coils nested together

The latest type is the diamond pulled coil, Fig. 5. This coil is wound on a shuttle and then pulled or

spread to shape either by hand or in a pulling machine. Fig. 7 shows the type of shuttle or form that the coil may be wound on, although a more elaborate one may be used in large shops. It consists of two pieces of lumber, one of which is mounted on a bolt, that may be used to support the shuttle in a lathe chuck when winding the coil. The center block *B* is just wide enough to take the number of wires that make the width of the coil. Fig. 3 shows a shuttle on a winding machine with a coil ready to be taken off. The shuttle Fig. 7 may be arranged to be turned by hand as in Fig. 6. In large shops a pulling machine may be used to spread the coil to shape. With a little care a good job can be done by hand as indicated in Fig. 8 One side of the coil is gripped in a vise between two pieces of wood about ⅛ in. longer than the armature slots. Then by clamping two similar pieces on the opposite side, the coil is pulled to the desired diamond shape by hand as indicated at *A* in the figure.

MAKING SHUTTLE TO WIND COILS ON IS AN EASY JOB

Making the shuttle to wind the coils on is a simple job that requires only one or two hours' work compared to a very complicated mold for the coils shown in Figs. 1 and 2. Another advantage of the diamond-shaped pulled coil is that in repair work the shuttles can be cut down for other jobs and there is not a stock of expensive molds on hand. The coil can also be wound complete with any number of wires in hand, thus saving considerable time. Fig. 5 shows the final shape of the pulled coils and how they nest together. The operations on making one type of diamond-shaped coils in the shop of one manufacturer are: After winding, the coils have a paper cell glued to the slot section, or they are tied so that the wires will hold together, then dipped in a good insulating varnish and baked, the



Figs. 6 and 7.—Shuttle for winding pull-type diamond-shaped coils

varnish holding the wires together. The next operation is to pull the coils to shape, then insulate and dip again.

Another type of coil is that made of strap copper. This coil is made up from bare copper strap, which is first cut in proper lengths, then bent on edge into a hairpin shape and the bends annealed and formed to shape on a wooden or iron former. Fig. 4 shows a complete strap-copper coil, which consists of 5 coils insulated together. This coil is for a wave-wound armature since the leads to the commutator bend away from the center of the coil. Sometimes it is possible to shape this type of coil on the pulling machine. In repair work it is seldom that such coils have to be made since, if the insulation is destroyed, it is only a matter of reshaping and reinsulating the coils.

Wherever possible in making a change in a winding having coils of the types shown in Figs. 1 and 2, they should be changed to a diamond-shape coil that can be

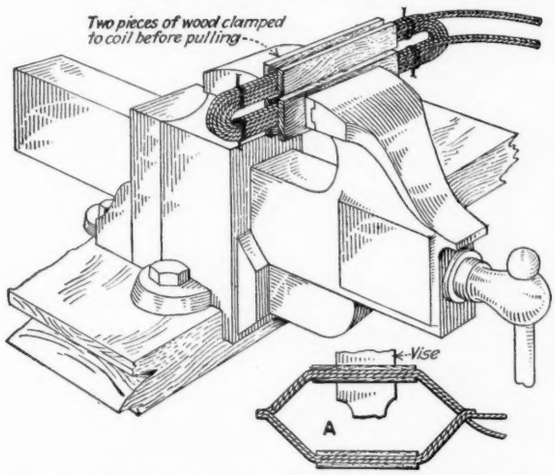


Fig. 8.—Method of forming diamond-shaped coils

wound as indicated in Figs. 6 to 8, which will result in considerable saving and will give as good a job if done right.

Assembling 15,000-Horsepower Impulse-Turbine Runners

BY RALPH BROWN

To permit assembly of the rotor spiders for a 22,222-kva. generator, the shaft, which weighed 32 tons, was shipped with but one bucket disk hub in position. The other hub, with the disk bolted thereto, was pressed on the shaft by the erecting crew. Equipment was available for doing this work with the hub at room temperature, but time and labor were saved by expanding the hub in the tank of hot water used during assembly of the generator rotor, as described on page 566 of the issue of April 8. This unit is of the double-overhung type, rated at 30,000 hp.

After removal of the rust-preventing compound applied at the factory, the diameters of the hub bores and the dimensions of the key slot were checked, the hub then being placed in the heating tank while at a temperature of 20 deg. C. and covered with water. The temperature of the water was raised to 92 deg. C. (198 deg. F.), and the hub was heated for 26 hours to insure uniform expansion.

In order to obtain contraction of the shaft, which is hollow, cold water was circulated through its bore for a period of 24 hours. This procedure reduced the temperature of the shaft from that of the room to 9 deg. C. The shaft was prepared for receiving the hub by being carefully finished and coated with a mixture of white lead and engine oil. Since the permanent key was not inserted until after the hub was in place, a short key having a sliding fit was used to insure accurate alignment of the key slots by guiding the hub along the shaft. Two timber cribs supported the shaft in a horizontal position near the heating tank.

When sufficiently heated, the hub was lifted from the heating tank by the 175-ton crane, being suspended therefrom at two points, by a cable sling and a 10-ton chain hoist, Fig. 1. The chain hoist was used to facilitate turning the hub to align the key slots.

Having two bores of different diameters, the hub was easily pushed half-way to its permanent position. At

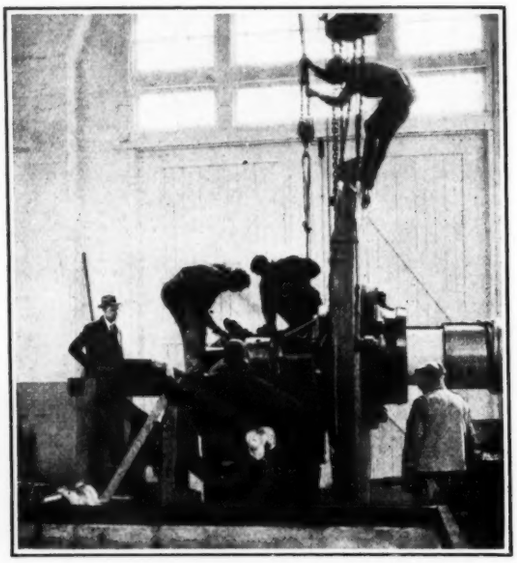


Fig. 1—Pressing bucket disk and hub on shaft after heating

this point a heavy cast-iron sleeve and bronze thrust washer were slipped over a 9-in. diameter steel stud that had been previously screwed into the shaft. Pressure was applied to the hub by screwing a heavy round nut against the thrust washer. The nut was turned by levers inserted in six equidistant holes about its periphery, the hub being nearly forced into position by use of the levers. Final pressing was accomplished by en-

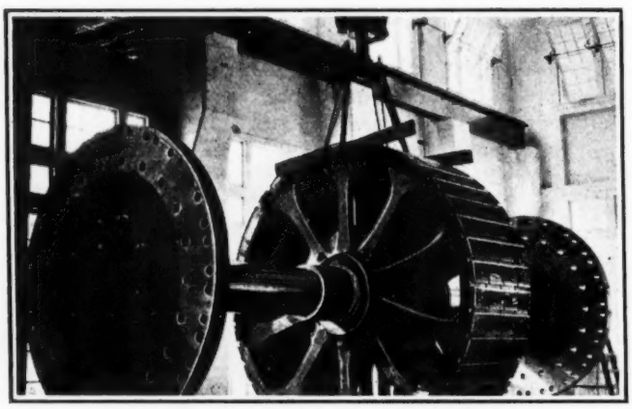


Fig. 2—Lifting generator rotor and runner disks

gaging slots in a special wrench with pins inserted in the holes in the nut, the levers being removed. This wrench was turned by means of the auxiliary crane hoist, each lift turning the nut through an angle of 45 degrees.

The hubs are made of close-grained cast steel of high ductility and are bored in two steps, the diameters of the bores being 22 and 21.875 in. These diameters were 0.012 in. less than the diameters of the shaft, and the heating process caused the hub to expand 0.011 in. Had the hub been pressed on the shaft at room temperature, a pressure of approximately 275 tons would have been required.

After removal of the guide key, the permanent key, approximately 4x3.5x30 in., machined 0.002 in. larger than the key slot, was driven home by a heavy battering ram suspended from the crane. The shaft, with both disks and rotor spiders in place, was placed in the bearings before assembly of the waterwheel buckets, Fig. 2.

Eight bolts having a taper of ¼ in. per foot of length and an average diameter of 3.656 in. secure the steel disk to the hub. The disk is 7 in. thick, its outside diameter is 10 ft. 11½ in., and its inside diameter is 39 in., being the same as that part of the hub with

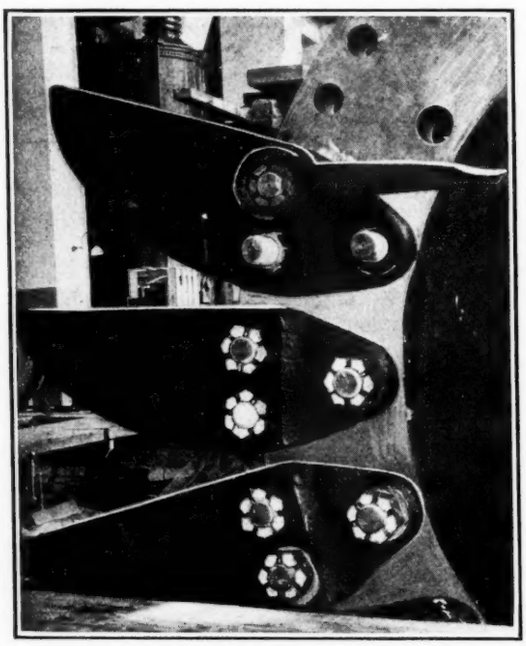


Fig. 3—Bolting buckets to runner disk

which it is in contact. The disk was easily placed on the hub after being slightly heated in the tank.

Twenty-one cast-steel buckets, each weighing 900 lb., are bolted to the disk. Each bucket is secured by three bolts, tapered similarly to the hub bolts, the average diameter of the largest being 4.14 in. and that of the two smaller ones, 3.64 in. Two slotted hexagon nuts are used on each hub and bucket bolt, a cotter key preventing the nuts from loosening. During assembly these bolts were drawn tight by striking a wrench with a sledge hammer, the large end of the bolt being driven in the disk at the same time by a heavy sledge. All bolts were coated with white lead and engine oil before being inserted. The completed wheel was given a protective coating of red lead.

No. 3 unit is practically a duplicate of the two units placed in service early in 1921, in the Caribou plant of the Great Western Power Co., and the runners continue to maintain the distinction of being the largest of this type in operation. The diameter of the jet impinging on each of the two runners is 11 in., the runners are 155 in. in diameter, their speed is 171.4 r.p.m., and the normal head is 1,008 feet.

Trenton Channel

THE Trenton Channel Station described in this issue is of interest in many ways. For one thing it is notable (though not unique) in having an ultimate capacity of 300,000 kilowatts, of which three 50,000-kilowatt units are being installed in the first section. These units, by the way, share with those at Hudson Avenue (Brooklyn) the distinction of being the largest ever mounted on a single shaft. But the mere bigness of this station will not interest designers and operating engineers so much as the many unusual features it embodies. Representing careful study by one of the best engineering staffs in the country—that of the Detroit Edison Co.—these will undoubtedly arouse much thought and discussion among power-plant engineers everywhere. It is not implied that these elements of design are either "good" or "bad," apart from the conditions existing in the particular plant where they are applied, but they certainly contain valuable suggestions for the designers of future stations.

Trenton Channel will burn pulverized coal exclusively, being the third large central station in this country to be so designed. As a transmission-system station, operating at variable station voltage, the auxiliary power is entirely divorced from the main bus and furnished from three sources—turbine-driven direct-current generators, turbo alternators, and a regular "customer" substation. The details of this auxiliary power system are of great interest. For example, the house turbines use river water for condensing the exhaust, feed heating being accomplished by steam bled from the main units at three points. The steel-tube economizers are protected from dissolved oxygen by an ingenious method of connecting the feed-storage tank into the system. The automatic condenser and pump priming system is also of interest, as is the bleeding of steam from house turbines for coal drying and the electrostatic precipitation of ash dust entering the stack.

Perusal of Mr. Berry's article will reveal many other interesting details which cannot be mentioned here for lack of space.

The Prime-Movers Report

AMONG the large attendance at the Technical Sessions of the N.E.L.A. last week there were many who felt that something was lacking. The Prime-Movers Report and the discussion of it, which in former years always proved to be one of the high spots of the technical session, were missing from this year's meeting.

It is true that there were substantial reasons for trying the present procedure of issuing the subcommittee reports serially throughout the year. The Prime-Movers Report had grown to such proportions as to constitute a large volume, and considerable difficulty was experienced in rounding up the reports of the various subcommittees, getting the volume edited and off the press on schedule time in order to afford opportunity for perusal before the convention. In fact, criticism on the convention floor two years ago of some unavoidable delay in this respect was probably a factor in changing the procedure.

In defense of the present method it has been pointed out that each of these subcommittee reports represents exhaustive work on the part of a well-qualified group of men and therefore leaves room for no discussion but should be accepted as is. It is no reflection on the value of any report, however, to point out that open discussion among a large body of men actually engaged in the work under consideration often brings out reactions and experiences that correspondence will fail to divulge. Moreover, the report in former years has been looked upon and retained by power-plant men as a ready and authoritative reference on plant practice. Its present form is not as susceptible to such use.

Co-ordinating the Power and Heating Demand

A FREQUENT objection to the combined power and heating plant is that the demand for power does not coincide with the heating load. As a result of this unconformity of demands much heat is lost through the atmospheric relief during the low heating-demand period, and in turn live steam is needed at other times to make up the deficiency in the exhaust supply.

There seems to be no apparent difficulty in adapting the regenerator idea to the industrial plant. By making use of one or more tanks of suitable capacity, the engine exhaust could be used to heat up a large amount of water kept under a few pounds pressure. If the heating process demands were low, the exhaust would raise the regenerator water temperature and at the same time increase by a few pounds the engine back pressure. In this way an exhaust loss to the atmosphere would occur only when the period of low heating demand was of long duration. In turn the large amount of hot water would, by the evaporation of part of itself, permit short-period withdrawals by the heating mains far beyond the capacity of the engine exhaust. By proper study of the conditions existing in any particular plant, a regenerator of suitable capacity to balance the engine output and heating demands may be chosen. The investment cost should not be prohibitive, since the tank need be built to withstand only low pressures. That this system is feasible is proved by the history of an installation in a coal mine where the hoisting-engine exhaust is fed to a low-pressure turbine through a load-balancing regenerator. The high-pressure regenerator is employed in industrial locomotives to a marked extent and has been adapted to industrial plant conditions, a notable installation being that in a large paper mill where the regenerator permits the boilers

to operate under a uniform load regardless of the variation in the steam demand.

A second type of regenerator has greater possibilities. This is in principle a gasometer, similar to the familiar gas-storage tanks. The engine exhausts into this tank which, by the weight of the telescopic section, is under a fixed predetermined pressure. Any excess of exhaust steam over the heating demand simply raises the tank top, increasing the volume while the pressure remains constant. The objection of large radiation losses is not serious, for by suitable insulation these losses may be kept low.

After observing the large amount of waste brought about by lack of co-ordination in the steam supply and consumption, an engineer will feel that the subject of regenerators is worthy of investigation.

Pipe Thrusts on Steam Turbines

STRAINS caused by piping have long been recognized as possible sources of steam-turbine trouble. The exhaust piping was originally, in all probability, responsible for more of these difficulties than that of the steam end. On both condensing and non-condensing machines the exhaust piping is relatively heavier and stiffer, and purchasers of prime movers were sometimes prone to disregard the requirements of flexibility. The lessons of vibration and misalignment became so well learned that extreme precautions, such as rubber or mercury expansion joints, have since in some cases been utilized.

The increase in unit capacity has tended to emphasize, on the other hand, the importance of the main steam connection. A greater unit capacity entails larger and stiffer pipes, increased length between turbine bearings, and a larger movement due to expansion from cold to running temperature. In addition to this the unit is relatively somewhat more sensitive to pipe thrusts from the fact that the blade clearances remain nearly constant, yet the increase of dimensions and cylinder expansion tends to make it more liable to misalignment trouble.

The elevation of temperatures and pressures adds to the difficulties of the problem. Although there is some tendency to decrease steam volumes with higher pressures, yet the increased strength required, together with the influence of temperature, actually results in a further stiffening of the steam pipe. Flexibility is decreased somewhat at the present temperature upper limit. It appears therefore that there is now a more pressing need for flexibility in the turbine piping, yet there is a somewhat greater difficulty in providing it.

Flexibility up to the present time has been obtained by adding to the length of, and increasing the bends in, a header connection. This introduces problems of pipe support, as greater expansive action must be allowed for and yet the pipe supports must not bind so as to prevent free movement. A long heavy pipe flexibly supported has usually a greater tendency to vibrate than shorter and stiffer designs. It may be necessary to adjust such connections in some instances against the periodicities of vibration ordinarily appearing in the floors or foundations.

Looking ahead to further elevation of temperatures and pressures it is known that piping materials lose their qualities of flexibility more rapidly than that of strength as temperature is increased. The problem of allowing for the expansion movement may be attacked by the use of specially designed slip joints, which is not very probable, or from the angle of eliminating the resistance of the prime mover. In the latter case it is conceivable that a short straight pipe connection, at cherry-red heat, may be run to a comparatively small high-pressure element, with the latter flexibly supported, so as to give in the direction required by the pipe thrust.

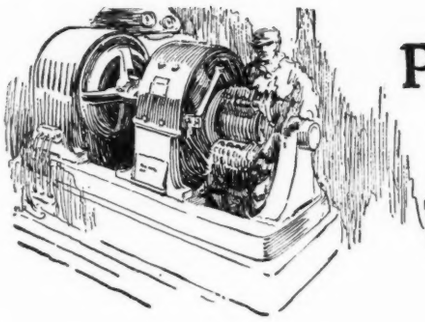
Newspaper Engineering

RECENTLY, announcement was made by an engineer that he had discovered a chemical which, when mixed with gasoline, reduced the amount of carbon monoxide in an automobile exhaust. This was commented upon by the *New York Times* in an editorial wherein the editor explained that, while the chemical might reduce carbon deposits, it must by the reduction actually cause an increase in the amount of carbon monoxide.

Apparently, the editor ventured on the subject unaware of the fact that the consumption of carbon need not necessarily produce the monoxide, since perfect union will result in carbon dioxide. While the carbon monoxide is highly poisonous, carbon dioxide is harmless and its only objectionable feature is that, if inhaled in larger quantities it may, by excluding life-giving oxygen, cause extreme discomfort or death.

Where all the exhaust steam from the engines and turbines in a power plant can be utilized for heating and process purposes, it is generally recognized that power can be produced cheaper in the industrial power plant than it can be purchased. The recent report of the committee appointed by the Associated Industries of Massachusetts to ascertain the facts with reference to the power situation in New England, expresses the relation between these power costs in concrete form. According to this report, in woolen- and worsted-mill plants of 500 kilowatts capacity, the net cost of generating power is 1.35 cents per kilowatt-hour, where the average price of purchased power to industries having a 500-kilowatt demand was 1.69 to 2.46 cents in New England. In plants of 3,000 kilowatts capacity, power was generated for a net cost of 0.87 cent per kilowatt-hour, where purchased power costs were from 1.35 to 1.90 cents on a 3,000-kilowatt demand. In the latter case the cost for purchased power is approximately double that of power generated in industrial power plants where all the exhaust steam can be utilized. Notwithstanding these facts, it is not uncommon to find high-pressure steam used for heating and process work and power purchased, when the processes could just as well be supplied with exhaust steam and the power generated in an isolated plant at lower cost than it is being purchased.

By the way, what has become of the recommendations of the Federal Coal Commission? Congress was quite willing to appropriate several hundred thousand dollars to have the investigation made, but continues to disregard the findings. Perhaps it is because, with summer approaching, coal does not form an attractive political topic. Nevertheless, with the coming of fall the public may again be reminded of the laxity of its representatives.



Practical Ideas *from* Practical Men

Why Should the Bearings Not Be Set Level?

On purchasing a direct-connected unit the instructions read as follows:

DIRECTIONS FOR SETTING SIDE-CRANK ENGINES ON FOUNDATIONS

A good level should be used; one in which putting one thickness of tissue paper under the end of the level will move the bubble at least $\frac{1}{32}$ in. With a sensitive level it will be found that the bearings of the shaft do not show exactly alike on the level. This is because the weight of the wheel and generator bends the shaft slightly and the boxes must be tipped to suit. When the shaft is placed on the lower half of the main bearings the level should show exactly the same on the shaft and on the planed surface of the frame where the main bearing cap bolts on; that is, the frame should not be set exactly level but should tip to correspond with the natural spring of the shaft due to the dead weight it carries.

What I should like to know is: Is it true that the shaft of such a unit could be made small enough to "spring" from the dead weight and still be strong enough to stand the torque? These instructions certainly explode my ideas on setting up an engine, as I thought that by having the bearings and bed level, I was doing the correct thing. And besides, wouldn't it be just as good to fit the outboard bearing to the sag in the shaft as to shim the bearing. What is happening in this sag at each revolution of the shaft?

I should be glad if some reader of *Power* who has had practical experience in erecting engines, would clear me up on these points. PIERRE WILLET.

Paulding, Ohio.

Attention to Details in the Power Plant

The successful engineer of today must get out of the old rut of letting things slide along in the easiest way if he wishes to remain in the good graces of his employer and rise in his profession. Attention to the details and keeping the engine and boiler room neat and clean will impress an owner or manager as much as the ability to repair a breakdown in a rush or skill in operating. In fact, breakdowns are not tolerated in the modern plant except in the most extreme cases, and economical operation is paramount.

Frequently, the engineer can save his employer considerable money by doing some of the small repairs himself instead of turning them over to outside help. Take the piston rods of boiler-feed pumps for instance. In many cases I have found these badly worn, with shoulders at each end, and instead of sending them to a shop to have them turned up, I have done a good job with a file and made them last twice as long before sending them out for repairs. The same also applies to the piston rings of the steam cylinders. If they are too loose, they can be made tight by removing them from the piston and peening them lightly all the way around on the inside with a ball-peen hammer; this will expand them and set them out against the cylinder wall. Care should be taken to use the hammer very lightly or the rings will be expanded too much.

Trouble is often experienced with the locknuts on the piston rod in the water end of pumps coming loose and scoring the cylinder. This can be effectively prevented by drilling a small hole through the rod just back of the nuts and inserting a cotter pin. In one plant which I was operating, two pumps were sent over from another plant and installed for boiler-feed service. The brass valve cages of these pumps were loose when I received them and had worn the bonnets of the pump so badly that the cages would leave their seats. To overcome this, I had a $\frac{1}{4}$-in. brass plate cast which took in the whole top of the pump and fitted over the cages. This held the cages in place and the pumps were practically as good as new. Particular attention should be given to pumps with piston steam valves; these need more oil in order to operate without trouble than any other pump I have had experience with. In many cases I have taken pumps apart when they were not working properly and discovered that all they needed was a little more oil.

Care should be taken not to run a vacuum pump too fast. If this is done and you lose the head of water in the system, the pump will invariably give trouble. In making this statement I have particular reference to a heating system where a fan or blower is used and where the vacuum-pump lines are in direct connection with the manifolds of the heating coils. In an installation of this kind it is necessary to have water in the lines, otherwise air will be pulled into the system. Some time ago I had considerable trouble with the manifolds and steam coils becoming airbound, and I overcame the trouble by drilling and tapping each manifold for $\frac{1}{4}$-in. pipe. These were connected to a $\frac{1}{4}$-in. header carried along above the manifolds. At the end of the header a regulating valve was used to control the outflow which I connected into the air duct. Proper manipulation of this regulating valve so as to keep up a slight circulation from each header, obviated further trouble with cold coils or manifolds.

With a blower system of heating it should first be determined just how fast to run the blowers to maintain the maximum temperature and obtain the most economical operation. Many engineers seem to think that the faster a blower engine is run the more heat will be delivered, but this is not the case. If the blower is run above a certain speed, the temperature of the air entering the shops will be lowered. In heating buildings at night with live steam, considerable saving of fuel can be accomplished by connecting the exhaust of

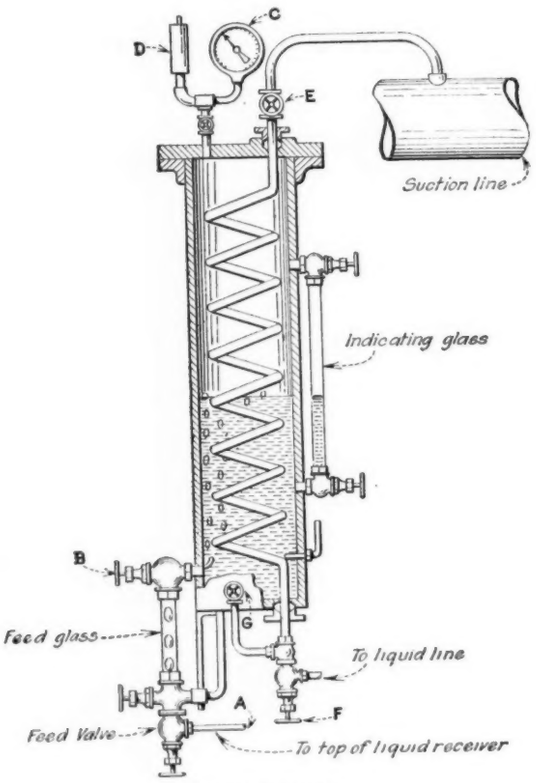
all the pumps directly into the feed-water heater. In one plant where this was done, the temperature of the feed water was increased 60 degrees.

We have come to the point where slipshod methods and guesswork are things of the past for any operating engineer who aspires to reach the top of the profession, and cleanliness, neatness, attention to details and a wide-awake attitude must be cultivated by the man who wishes to succeed in this field. C. MOTTERN.

Cincinnati, Ohio.

Does One Lose Ammonia When Purging?

Recently, a refrigerating engineer, in discussing a non-condensable gas separator, which is herewith shown, stated that the separator would remove nothing but the non-condensing gas. The method of operation as claimed by the builder is as follows: A line *A* is led



Purging device

from the top of the liquid receiver, and the gas above the liquid is permitted to pass through the valve *B* into the tank.

The cylindrical part of the separator is partly filled with liquid ammonia and maintained at a pressure of 100 lb. per sq.in. Liquid ammonia is then expanded through the ¾-inch spiral expansion coil, which reduces the temperature of liquid carried in the separator to a point ranging from 50 to 60 deg. below the boiling point corresponding to the pressure mentioned.

By passing through this liquid, the condensable, or pure ammonia, gas coming through valve *B*, that would otherwise be lost, is liquefied and returned to the system. The non-condensable gases thus separated, rise above the surface of the liquid and build up a pressure on the gage, and when the pressure reaches 100 lb., relief valve *D* will open slightly, and as fast as the gases are admitted to the separator, they will be released to atmosphere through valve *D*.

The builders state that without non-condensable gases in the system there can be no pressure maintained on gage *C*. When started, it will remain in continuous operation with a steady and regular discharge from valve *D* with a pressure of 100 lb. on the gage *C*. When the system is entirely cleared, the pressure will drop and valve *D* will cease to operate. The maintenance of a pressure on gage *C* is entirely dependable on the presence of non-condensable gases, as it is plain to be seen that condensable gas cannot pass through a body of cold liquid ammonia without condensing.

The liquid ammonia, by absorbing the condensable gas, will build in volume, and when this reaches a point somewhere around the top of indicating glass, the salvaged liquid is returned to the system in a few seconds by slightly opening *G*, which allows the liquid to return through a ¼-in. by-pass back into the system.

These statements would indicate that there is no ammonia vapor above the level of the liquid in the separator and that whenever valve *D* opens no ammonia vapor escapes with the non-condensable gases. I cannot understand the reasoning and would be glad if some *Power* reader would explain why no ammonia vapor is in the separator.

Take the builder's own statement of the temperature carried in the separator, namely, 14 deg. F. When ammonia liquid is placed in a vessel, an amount of the liquid will evaporate until the pressure exerted on the surface of the liquid by the ammonia vapor is equal to the vapor pressure at the temperature of the liquid. It does not make any difference whether the space be already occupied by another gas. For liquid ammonia at 14 deg. F. the pressure of the ammonia vapor will be 41 lb. per sq.in. absolute. As more ammonia gas and non-condensable gas enters through the valve *B*, the ammonia gas will condense so that the ammonia vapor pressure still stays at 41 lb. abs. and will so register on the gage, the builders' statement nothwithstanding. Taking a concrete case, let us assume that the separator is 18 in. in diameter and that the space above the liquid ammonia when the valve *D* blows at 100 lb. per sq.in. gage is 24 in. high; this would give a volume of a little over 3.5 cu.ft. The weight of ammonia vapor at 14 deg. F., and 41 lb. abs. in this space would be 0.52 lb. If the non-condensable gases raise the pressure to 100 lb. gage, this means that these gases are exerting a pressure of 115 — 41 = 74 lb. Assuming that the gas is air, the weight of the air above the liquid may be calculated by the formula

$$144PV = MRT$$

where P = pressure in lb. per sq.in. = 74 lb; V = volume in cu.ft. = 3.5; M = weight of air; R = 53.34; T = abs. temperature = (460 + 14).

Then

$$M = \frac{144\,PV}{RT}$$ and by substitution $$M = \frac{144 \times 74 \times 3.5}{53.34 \times 474} = 1.47 \text{ lb.}$$

If the valve *D* be opened at 100 lb. and the amount of gas coming over from the receiver be sufficient to maintain the pressure at 100 lb., a little more than a third of the gas escaping is ammonia.

If I am wrong in my logic and conclusions, I want to be put right by some of *Power's* readers, for the management is seriously considering the installation of a purging device of this kind. JOHN CASSIDAY.

Jersey City, N. J.

Comments from Readers

Power-Plant Legislation in Holland

Many executives and leading business men in this country are strongly opposed to a national superpower system on account of the application of municipal and provincial laws preventing the generation of electric light and power by private companies or persons, whether they sell their product cheap or not. As a consequence the rates are in general exceedingly high, and now that the war is over and coal and oil are easily procurable, the isolated plant comes again into its own and can compete easily with the central station.

A semi-official body in the province of Friesland intended to install a wind motor in a small pumping station, serving a drained area. Its application was filed but promptly rejected. The provincial authorities ordered simply the installation of an electric motor because they considered this action to be in the interest of the growth of the provincial central station.

A superpower bill was defeated a few years ago in the House of Commons, chiefly because the data on the cost of the power per kilowatt-hour were very indefinite, therefore the required amount of fifty million dollars was refused.

The general results of the big provincial stations have been, on the whole, unsatisfactory, and as a consequence we witness the revival of the isolated plant and the severe competition of the motor bus against the municipal electric railways. I think in this country decentralization will win the battle for the time to come.

Schoonhoven, Holland. H. WIELAND LOS.

Caustic Embrittlement

In an editorial, "Caustic Embrittlement," in the April 15 issue, reference is made to my paper before the A.S.M.E. in 1915, that deals with the prevention of scale and corrosion in boilers. The second paragraph of the editorial states that my paper referred to, points out "that caustic soda results from the use of soda ash under steaming conditions and liberates nascent hydrogen that attacks the steel, causing embrittlement and cracks extending from the rivet holes outward."

It is possible that paragraph 35 of that paper has been twisted from a statement of theories advanced to me as to the cause of the trouble, into an expression of our experiences with this kind of trouble, which is a distortion of fact obvious to anyone who will read the first line of that paragraph.

In paragraph 62 of the paper it is stated distinctly that no such cracks or other evidences of embrittlement had been observed up to that time in the boilers in question; to which can be added now, that up to the present time that statement still holds true; furthermore, that these boilers have been under 3 per cent normal alkaline strength solution ever since it was first introduced, in 1914.

Recently, a number of the drum bellies have been replaced because of the corrosion and grooving that took place before the Navy compound was used. Sample strips taken from these plates at points where embrittlement might be expected to occur (if at all) and pulled in a standard testing machine, showed physical conditions equal in every respect to the original tests made before the boilers were fabricated. It will be seen, therefore, that, this 3 per cent normal strength having been introduced in these boilers in 1914 and continued daily to date, we have ten years' continuous experience under operating conditions, without ever having been able to discover the slightest evidence of trouble from hydrogen embrittlement. A. H. BABCOCK.

San Francisco, Calif.

[Mr. Babcock is correct in his surmise as to how these views were erroneously attributed to him. A rather hasty perusal of an abstract of his original paper, without reading the whole paper, led to this conclusion.—Editor.]

Heat-Work Conversion

In the March 25 issue W. R. Williams has a communication in which he questions or rather disproves (to his own satisfaction) the heat-work conversion law as generally accepted.

The keystone of Mr. Williams' arch of reasoning is found in the two sentences in which he states that throughout the stroke the rejected portion of the heat acts to maintain part of the pressure, and that, since the pressure alone does work, the rejected portion has done work.

Let us consider exactly what takes place when the heat is added to the working fluid (in this case a gas) just before the start of the working stroke. The added heat produces an increased rate of vibration of the molecules of gas, and since they are free to move about, the impact of the molecules on one another and on the piston and cylinder walls will give them an increased velocity. The result of all this is that the added heat has given the molecules, by increasing their velocity, an increased kinetic energy.

Mr. Williams says that pressure only will do work. Quite so, but pressure will only do work through the medium of the rapidly moving gas particles giving up part of their kinetic energy to the piston. Let us now consider a single gas particle. A certain amount of heat has been added to it, producing an increased velocity and hence an increase of kinetic energy. Part of this added heat will be "converted" and part will be rejected. All this added heat acts to maintain the velocity and hence the kinetic energy of the molecule. The molecule now strikes the piston, moves it a very short distance and rebounds from it at a decreased velocity. Some work has been done on the piston, and this work was obtained from the kinetic energy of the molecule. The work done is equal to the difference of the kinetic energies before and after impact. The molecule still has some kinetic energy, but this kinetic energy has done no work.

If we follow Mr. Williams' reasoning to its logical conclusion, we must agree that the heat remaining in the molecule after impact, and hence its kinetic energy after impact, has done work. That the remaining kinetic energy of a body after impact on another body should have done any work, is of course at variance with Newtonian mechanics. Hence we see readily the absurdity of Mr. Williams' contention.

Since the remainder of Mr. Williams' theories rest solely upon this one hypothesis, it is useless to discuss them further.

I should be glad to hear what some of the other readers of *Power* have to say in answer to Mr. Williams.

SAMUEL M. HAMILL, JR.

Cincinnati, Ohio.

Systematic Arrangement of Switches Simplifies Operation

The article in the March 11 issue entitled "Throwing Wrong Switch Leads to Turbine Wreck," recalls some of my earlier experiences in the engineering line, and it is a marvel to me that there are not more accidents

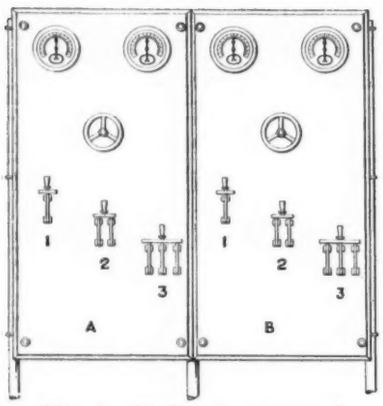


Fig. 1—Switches arranged on panels in same relative position

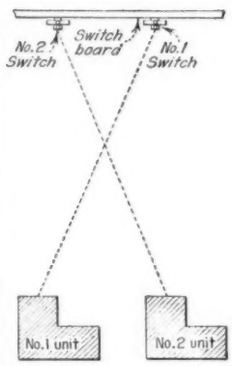


Fig. 2 — Arrangement of units and connections

from this cause, considering the way even so-called modern switchboards are installed.

While it is not to be expected that every switchboard should be controlled by master switches and push buttons that will automatically parallel different generators as desired, much can be done to make this operation as simple and foolproof as possible by a systematic arrangement of the switches on the several panels so that a new man will have a chance to operate them without trouble.

By way of illustration a typical switchboard for two units is shown in Fig. 1. It will be seen that the switches on the panels *A* and *B* are marked 1, 2 and 3, and of course are arranged to suit installation requirements. The point is that wherever any switch is on panel *A*, it should be in a similar position on panel *B*. On several switchboards I have seen, the switches were arranged differently on each panel and the fact that there were not more accidents speaks well for the operating crew.

Some years ago I worked as engineer in a large hospital where three engineers and a chief were employed. In this plant the operating conditions were anything but good. A diagrammatic layout of the units and switchboard in this plant is shown in Fig. 2. No. 1 unit, a 75 kw. direct-current machine, was operated from about 8 o'clock in the morning to about 10 o'clock at night, when No. 2 was put on for the light-load period.

To shift the load from one unit to the other without pulling the wrong switch required practice, and as the engineers changed shifts every week, the men hardly got accustomed to changing from one machine to the other before they went on the next shift, where no changing was required. The result was that the lights frequently went out, causing a lot of trouble, as there were several motors running, all of which had to be restarted separately in various parts of the building.

After several interruptions in the service had occurred, the engineers tried switching over the units another way —as one main switch was closed, the other was pulled out. I understand the plant was operated in this way for seven or eight years until a new chief engineer was engaged and he had the leads changed over to the right switches.

O. G. PETTERSSON.

Winnipeg, Man.

Cost of Bled Steam

In a contribution to the May 20 issue G. B. Randall pointed out that the saving resulting from the use of bled steam in the example worked out in my recent comments on the subject would be 44 per cent instead of 5 per cent, as was shown in the article. As might be supposed, the error was made in transcribing the figures in preparing the article. I am much indebted to Mr. Randall for calling the error to the attention of the readers of *Power*.

I cannot agree with Mr. Randall's ideas regarding the division of charges for heat between the electric power and the heating, so as to proportion the charges according to the actual heat absorbed. He believes that if only 8.5 per cent of the heat supplied to each pound of steam is actually absorbed in the turbine, only this percentage should be charged to the production of electrical energy.

If in an industrial power plant with turbines that run condensing at 20 per cent efficiency, there was some use for the portion of the steam exhausted from the turbine at approximately 100 deg. F., Mr. Randall would want to charge 80 per cent as much for a pound of this steam as for a pound of live steam. The absurdity of charging as much for available heat in the form of steam at this temperature as for heat in the form of live steam should be at once apparent when it is considered that this heat is normally dissipated in the river or cooling pond and is economically valueless.

As Mr. Randall seems to agree with my equations, which for the case considered showed that the use of bled steam is 44 per cent cheaper than the use of live steam for heating, it seems strange that he would want to charge as much for the bled-steam heat as for an equivalent amount of live-steam heat. Such a method of charging would offer no inducement for the use of bled steam rather than live steam, which he admits is more expensive to supply.

It seems to me that when steam is bled from a turbine for industrial uses, its cost is that of the additional live steam that must be supplied to maintain the same electrical output, allowances being made for a variation in the amount and temperature of the condensate returns.

Springdale, Pa. C. E. COLBORN.

Measuring the Feed Water in a Boiler Test

In the article, "Measuring the Feed Water in a Boiler Test," in the April 8 issue, the illustration Fig. 1 shows two feed pumps so connected that only one can be used while measuring the water. While one pump in good condition would be expected to do the work during a test without trouble, in my opinion it would be well to provide connections so that either pump could be used if necessary. This could be done by installing a valve in the discharge line from the heater below where the connection is taken off for the weir tank. The author also suggests the use of plugged tees instead of elbows in the feed piping, but a more convenient method would be to use short nipples and valves in the outlet of the tees instead of plugs, but probably most owners of small plants would object to this on account of the extra cost.

Bristol, Conn. W. Q. PERKINS.

The Use of Superheated Steam in Power Generation for Wood-Pulp and Paper Mills

Some of the points in J. D. Morgan's remarks in the April 15 issue on "The Use of Superheated Steam in Power Generation for Wood Pulp and Paper Mills" are well taken, but there are other considerations that must also be taken into account. While the products all come under the general head of paper, the power requirements and economic problems of the news mill are different from those of the book-paper mill and these again entirely different from the box-board mill, so that there is no general solution of the case. For instance, cheap hydro-electric power is an essential for producing news paper, as the amount of power required in preparing the ground wood pulp, the main constituent, is so great that the cost of steam power would be prohibitive. This does not mean that the water power must be adjacent to the plant, but that the ground wood is prepared by hydro-electric power and shipped to the point of paper manufacture. Opinion as to the advantage of steam engine or electric drive for news machines is divided, though to judge from the installation of electric drive on most of the new high-speed news machines, the opinion of practical paper makers favors the latter on account of more accurate and convenient control.

Book paper, like all quality products, is more dependent on able supervision and skilled labor supply; granted which, details of equipment are relatively less important. Such machines are run at more moderate speeds and steam-engine drive is usually preferred from a cost viewpoint, as electric drive is expensive—running as high as $50,000 for a single machine.

Box board is largely a problem of reworking waste paper, and the location of mills tends to gravitate toward centers of waste-paper supply and consumption of board. Speeds are usually low on account of drying requirements, and steam-engine drive is almost universally employed. In board mills the balance between power and drying steam varies, mills making the poorer grades of board requiring little power for the preparation of the stock, usually having a deficiency of exhaust steam from their engines and completing the drying with live steam, while those making the higher grades of lined or patent coated boards require an excess of power and use condensing-bleeder turbines or reject the exhaust to the atmosphere. The best condition is a slight deficiency of exhaust steam so that none will be wasted.

Superheated steam is by no means unknown in the paper business, but to introduce it in most existing mills would be a difficult problem, as practically all present valves, fittings and flanges are cast iron, which would have to be replaced with cast steel and special means provided for lubrication of the slide-valve and Corliss engines generally installed. In only a few cases would it be possible to obtain superheated steam without installing new boilers, as a separately fired superheater would offer some rather dangerous possibilities of overheating in the average industrial boiler room, and if this were the case the writer believes that practically equal economy and simpler operating results could be obtained by raising the pressure to about 250 lb. and operating with saturated steam, as with such a pressure, moderate back pressures, up to, say, 10 lb. could be carried without excessive increase of steam consumption in the engines of turbines.

I am rather skeptical of Mr. Morgan's statements that superheat will reduce maintenance costs, and while it is possible that in a small degree superheaters will increase boiler efficiency and increase the capacity of the plant, the same expenditure on economizer surface either as a separate or integral economizer will produce much greater results. In cooling sulphite in the digesters the dilution of the acid in the early part of the cook should be held to a minimum, but under average conditions it is doubtful if over 100 deg. F. superheat can be maintained entering the digester, giving less than 60 B.t.u. per lb. additional heat, or about 7 per cent of the 860 B.t.u. latent heat of the steam, so that the change in dilution will be comparatively small and hard to detect.

A point where many designers and consulting engineers fall down in planning changes is to figure the saving possible on the basis of their hypothesis and then treat it as an assured fact without considering the possibilities of some of the conditions not working out as anticipated. This is usually the case as it is seldom that all the expenditures necessary can be foreseen, particularly when making changes without interfering with the operation, and often it is found that some requirement has been overlooked that will seriously modify the results. Another is to avoid complicated or easily deranged apparatus in any part of the process where continuous operation is essential to production, as the criterion is not how a piece of apparatus works when everything is going right, but how it can be depended on to keep going when everything is going wrong.

The consideration that outweighs all others with the operating man is reliability, for it takes only a short shutdown with complete loss of production to waste more money than the apparatus could save during its whole life in the mill, so that unless engines especially adapted to superheated steam, preferably with poppet valves, are installed and a satisfactory opportunity afforded to break in the operating force to the care of the new equipment, some expensive interruptions are likely to happen.

A good motto for every engineering office and drawing room would be, "No piece of apparatus is economical when the mill is shut down." A. D. FISHER.

New Haven, Conn.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Allowance for Expansion of Steam Line

What provision should be made for expansion of a 3-in. steam pipe line 125 ft. long for carrying dry saturated steam at 150 lb. gage pressure? *W. C. S.*

The coefficient of expansion or contraction of steam pipe is about 0.0000065 per degree F. change of temperature. The temperature of steam at 150 lb. gage is 366 deg. F., and assuming that the pipe is erected at the temperature of 60 deg. F., the change of temperature would be 306 deg. F. with a total expansion of $306 \times 0.0000065 \times 125 = 0.249$ ft., or about 3 in. If one end is anchored, this expansion must be taken up at the free end of the line, or if both ends are anchored, the expansion will be from the ends towards the middle, in either case requiring an expansion joint capable of taking up the whole amount of the expansion. By firmly anchoring the line in the middle of its length with expansion of 1½ in. in both directions, the elongation can be taken up by an expansion joint at each end or by allowing for the movement with long spring connections.

Relative Boiler Efficiencies Burning Coal or Fuel Oil

For small plants, what are the relative efficiencies of boilers using fuel oils and of coal burning boilers? *R. W.*

Most coal-burning boilers of small plants operate at efficiencies of less than 65 per cent, while with oil fuel, boiler and furnace efficiencies of over 75 per cent are not unusual. This greater efficiency arises partly from the fact that oil is readily broken up and brought into contact with the air necessary for its combustion and the loss from excess air is correspondingly reduced.

Testing Tightness of Check Valve in Return Line

What is the best and quickest method of determining whether the check valve leaks on a return line of a heating system? *R. M. C.*

By shutting off the steam supply to all pipes and radiators that are connected with the return that contains the check valve, then if it leaks the resulting reduction of pressure in the radiators would permit of a back flow of steam or water from other apparatus connected with the same return line on the discharge side of the check valve. If the return is provided with a bypass waste and stop valve outside of the check valve, a quick method of testing the tightness of the check valve would be to close the return stop, open the bypass and observe whether leakage is shown by discharge through the bypass.

Stretch in Elevator Cables

If a vertical hydraulic elevator has, say, 100 ft. of travel and is equipped with new hoisting cables and the lower limit is set to stop the car level with the bottom landing, what position will the car stop at 15 to 30 days after installation of the cables, provided no adjustments are made on the machine in the interval? *W. H.*

The car may be expected to stop from one to two feet below the landing because of the stretch that takes place in new cables shortly after installation. If the machine is of the horizontal type, the cables will stretch from one to three feet within three to four months after installation.

Condensate Formed in Short Pipe Line

What amount of condensate would be formed per hour from carrying steam at 20 lb. gage pressure in a 10-in. pipe line 20 ft. long, through a space where the outside temperature of the surrounnding air is 60 deg. F., when the pipe is bare and when covered with a good nonconducting covering? *W. L. S.*

The condensate formed per square foot of pipe surface per hour depends on the rate of heat loss due to difference between the temperature of the steam and the temperature and activity of circulation of the air surrounding the pipe. With ordinary ventilation of the space through which the pipe passes, the loss of heat for a bare iron or steel pipe would amount to about 2½ B.t.u. per degree difference of temperatures inside and outside of the pipe, per square foot of external pipe surface per hour.

The temperature of dry saturated steam at the pressure of 20 lb. gage, or 35 lb. per sq.in. absolute, is 259.3 deg. F., and with the temperature of the air 60 deg. F., the loss of heat would amount to $(259.3 - 60) \times 2\frac{1}{2} = 498.5$ B.t.u. per square foot of external pipe surface per hour. Standard 10-in. steam pipe has an external diameter of 10.75 in. and the external surface of a pipe 20 ft. long would be $\frac{10.75 \times 3.1416}{12} \times 20 =$ 56.29 sq.ft., so that the loss of heat from a bare pipe would be $56.29 \times 498.5 = 28{,}060.7$ B.t.u. per hour.

As this heat loss would be sustained by the loss of the latent heat of the steam that is condensed, and the latent heat of one pound (weight) of dry saturated steam at the pressure of 20 lb. gage is 938.9 B.t.u., with bare pipe, the amount of condensate formed would be $28{,}060.7 \div 938.9 = 29.89$ lb. per hour. Using a pipe covering of good quality, 2 in. thick, if kept dry, about 80 per cent of the loss from bare pipe would be saved and the condensate would amount to about 6 lb. per hour.

Flow of Steam in Four-Inch Pipe

What amount of steam would flow through a 4-in. pipe 400 ft. long and what would be the pressure drop where the initial pressure is 10 lb. gage. B. M. C.

The amount of flow per minute would depend on the pressure drop or, on the other hand, the pressure drop would depend on the amount of steam flowing per minute. One or other of the factors must be given. The formula generally used is

$$W = 87\sqrt{\frac{wPd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

where

W = Weight of steam flowing per minute in pounds;
w = Mean density of the steam, or weight per cu.ft.;
P = Drop in pressure, pounds per sq.in.;
d = Internal diameter of pipe, inches;
L = Length of pipe in feet.

For greater convenience in its use this formula may be simplified to the form,

$$W = c\sqrt{\frac{Pw}{L}}$$

where

W = Weight of steam flowing in pounds per *second;*
P = Pressure drop in pounds per sq.in.;
w = Mean density of the steam in the pipe;
L = Length of pipe in feet;
c = A constant whose value depends on the size of pipe, as follows:

For nominal 1-in. pipe,	1.05-in. actual internal dia.,	c =	0.77
For nominal 1¼-in. pipe,	1.6 -in. actual internal dia.,	c =	2.59
For nominal 2-in. pipe,	2.07-in. actual internal dia.,	c =	5.39
For nominal 2½-in pipe,	2.47-in. actual internal dia.,	c =	8.86
For nominal 3-in. pipe,	3.07-in. actual internal dia.,	c =	16.24
For nominal 4-in. pipe,	4.03-in. actual internal dia.,	c =	34.22
For nominal 5-in. pipe,	5.05-in. actual internal dia.,	c =	63.51
For nominal 6-in. pipe,	6.06-in. actual internal dia.,	c =	103.82
For nominal 7-in. pipe	7.02-in. actual internal dia.,	c =	114.55
For nominal 8-in. pipe	7.98-in. actual internal dia.,	c =	216.05
For nominal 9-in. pipe,	8.94-in. actual internal dia.,	c =	292.46
For nominal 10-in. pipe,	10.02-in. actual internal dia.,	c =	395.12

Assuming in the question that the drop in pressure is 4 lb. per sq.in. and uniform, with an average pressure of $[10 + (10 - 4)] \div 2 = 8$ lb. gage, or 23 lb. absolute, from the steam tables find for the density, $w = 0.05676$ lb. per cu.ft. Then by substituting c, for nominal 4-in. pipe $= 34.22$, $P = 4$, $w = 0.05676$, and $L = 400$ ft., the formula becomes,

$$W = 34.22\sqrt{\frac{4 \times 0.05676}{400}} = 0.8144 \text{ lb. per second}$$

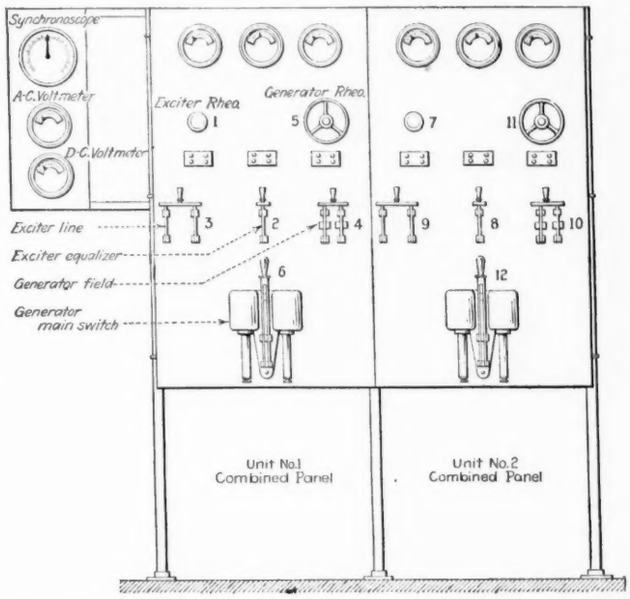
Numbering Switches To Indicate Operating Sequence

Two turbine-driven alternators of 500 and 750 kw. capacity respectively, with direct-connected exciters, must be phased in with each other. There is no voltage regulator. Later on, one unit must be cut out. How could switchboard operation be guided so as to prevent throwing the wrong switch? L. C. A.

By numbering the switches and rheostats, the sequence of operations at the switchboard may be represented for phasing in. For cutting out, very nearly the reverse sequence is to be followed. Tables as given herein, may be posted for guiding the operators.

The system may be extended so as to include numbers of plug receptacles, etc., but undue complication is not desirable. By keeping the moves plainly in view, the auxiliary operations will tend to suggest themselves naturally. Tables I and II cover the work of phasing in unit No. 1 and cutting out unit No. 2. Similar tables may be made up for phasing in unit No. 2 and cutting out unit No. 1. Sequence in Table III would be 7, 8, 9, 10, 11 and 12; in Table IV, 6, 5, 4, 3 and 2.

The figure shows the general plan of two combined generator and exciter panels. If a separate exciter



Combined generator and exciter panels numbered to guide in switching operations

panel is provided, the equipment for both exciters installed on it may be numbered in the same manner as if on a combined panel.

TABLE I—UNIT NO. 1 BEING BROUGHT TO SPEED AND PHASED IN WITH NO. 2

Switchboard Number	Operation
1	Bring unit No. 1 with direct-connected exciter to speed. **Adjust exciter voltage to normal by means of rheostat** ..... (1)
2	See that equalizing switch on exciter No. 2 is closed. **Close exciter No. 1 equalizer switch**..... (2)
3	See that exciter No. 1 voltage equals that of No. 2 and **close exciter No. 1 line switch**..... (3)
4	See that resistance is all in, on main field of gen. No. 1, so that the no voltage position is reached by gen. No. 1 rheostat (5). **Put light field on gen. No. 1 by closing main field switch**..... (4)
5	**Put normal field current on gen. No. 1, by adjusting voltage to normal by means of rheostat**..... (5) Watch exciter loads. If exciter voltage drops seriously or loads do not divide satisfactorily, adjust to normal by means of both exciter rheostats, (1) and (7).
6	To phase in the generator, plug in synchronoscope and adjust speed of incoming machine by means of turbine governor synchronizing spring until "scope" travels slowly, so as to make it easy to phase in. See that both generator voltages are equal. **Phase in the incoming machine, so that the "scope" stops at 12 o'clock by closing the main switch**..... (6) Take out synchronizing plugs. Adjust governor synchronizing springs and generator field rheostats so that load and power factor are divided satisfactorily. Generally speaking, these should be in ratio of machine capacities.

TABLE II—UNIT NO. 2 BEING CUT OFF THE BOARD

Switchboard Number	Operation
12	See that synchronizing plugs are out of their sockets. Cut down wattmeter and ammeter load on gen. No. 2 by means of turbine synchronizing springs, and field rheostats, (5) and (11). Regulate exciter voltage at times if required. **Open gen. No. 2 main switch** 12
11	**Cut gen. No. 2 field down to zero by means of field rheostat** ..... 11 Watch exciter loads and adjust if necessary by means of exciter rheostats (1) and (7).
10	**Open gen. No. 2 field switch** 10
9	Cut exciter No. 2 load to zero, by means of exciter rheostat (7). Regulate voltage of exciter No. 1 if required. **Open exciter No. 2 line switch** 9
8	**Open exciter No. 2 equalizer switch**..... 8 Shut down turbine and exciter.

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

The Quality of Exhaust Steam

THE statement is often made that an engine or turbine acts exactly like a reducing valve in its effect on the steam. While this statement is an approximation to the truth and is sufficiently accurate for some purposes, it is not exact; the steam passing a reducing valve will always have a higher superheat or quality than that exhausted by an engine or turbine supplied with the same initial steam. The difference in quality or superheat between the steam leaving the reducing valve and that exhausted by the engine or turbine will depend upon the efficiency of the latter, the superheat or quality being lower the higher the efficiency of the prime mover.

Suppose that a reducing valve, a duplex pump, an ordinary slide-valve engine, a Corliss and a unaflow are all supplied by the same steam main containing dry saturated steam at 150 lb. gage pressure. If they all exhaust at 20 lb. absolute (approximately 5 lb. gage), the exhaust of the reducing valve will be superheated 83 deg. The condition of the other exhausts will depend on the steam rates. The following steam rates may be assumed: Duplex pump, 100 lb. per i.hp.-hr.; slide-valve engine, 45 lb.; Corliss, 30 lb.; unaflow, 20 lb. The corresponding exhaust conditions will be about as follows: 30 deg. superheat for the duplex pump, 98 per cent dry for the slide-valve engine, 95 per cent dry for the Corliss, and 91 per cent for the unaflow.

Why Greater Efficiency Means Lower Quality

To make clear the reason for this variation, consider what happens when steam passes through the reducing valve. The opening in the valve forms a kind of orifice, through which steam is forced at high velocity. Moving steam has kinetic energy the same as a moving flywheel or rifle bullet. This energy is obtained at the expense of some of the heat in the steam. So, since the initial steam has a total heat of 1,195 B.t.u., that discharging from the valve opening must have a smaller total heat. The amount of this reduction need not be figured, as it is all returned to the steam before it has traveled far. That is to say the high velocity of the steam leaving the valve opening soon disappears as the steam spreads out to fill the discharge pipe. In being thus slowed up, the kinetic energy of the jet is dissipated in internal friction which returns to the steam an amount of heat equal to that abstracted in the form of velocity energy.

This is just another example of the law of conservation of energy, which states that energy cannot be created or discharged, but only changed from one form to another. The steam leaving the discharge pipe must contain all the energy it initially held, except that which passes elsewhere. The only way that energy can leave steam passing through a reducing valve is by radiation from the outer surface of the valve and pipe to the air. The amount so lost from each pound of steam in a short section of piping is too small to be considered if any large amount of steam is flowing.

Since the velocity of the steam in the discharge pipe is considerable, it may be thought that the kinetic energy there may represent an appreciable portion of the total energy in the steam, but such is not the case. The formula for kinetic energy is $E = \frac{MV^2}{64}$, where E is the kinetic energy in foot-pounds, M the mass is pounds and V the velocity in feet per second. For one pound of steam flowing at a velocity of 100 ft. per sec. (considerably more than a mile a minute) this reduces to $E = \frac{1 \times (100)^2}{64}$ = 156 ft.-lb. Since it takes 778 ft.-lb. to make one B.t.u., this is equivalent to about one-fifth of a B.t.u., which is negligible in comparison with the total energy of 1,195 B.t.u. in each pound.

The velocity of the steam just leaving the opening might be about 1,500 ft. per sec.; fifteen times that in the discharge pipe. This would represent 225 times as much kinetic energy, since kinetic energy is proportional to the square of the velocity, as may be seen from an inspection of the formula.

No Heat in Reducing Valve

It may then be said without appreciable error that the total heat per pound in the steam discharged from the reducing valve is the same as that in the original high-pressure steam; that is, 1,195 B.t.u. At the assumed back pressure of 20 lb. absolute, the total heat of a pound of dry saturated steam is 1,156 B.t.u. In order for the exhaust steam to contain the additional 39 B.t.u., it must evidently be superheated. The specific heat of superheated steam at this pressure is 0.47; that is, it takes 0.47 B.t.u. to superheat one pound of steam one degree. Therefore the amount of superheat can be determined by dividing 39 by 0.47. This gives 83 deg.

With the duplex pump and the engines the case is somewhat different, since power apparatus must remove from the steam at least enough energy to accomplish the outside work performed. In this the so-called losses due to friction, throttling, etc., play no part, except in so far as they actually carry energy away from the steam. For example, wiredrawing and leakage past the piston and valves might be considered losses, but these do not carry heat away from the steam. The same applies to piston friction, because the heat so developed is returned to the steam in contact with the piston. On the other hand the friction of the crosshead and main bearings, radiation from the cylinders, etc., represent heat actually removed from the steam.

Figuring Pump Exhaust

Roughly, the heat taken away is represented by the indicated horsepower, since practically all of the i.hp. is delivered to the piston rod, except for the small deduction due to piston friction, and this is roughly balanced by the loss by radiation from the cylinders. One indicated horsepower is equal to 2,545 B.t.u. To figure the approximate amount of heat removed from each pound of steam by the engine, it is only necessary to know the steam consumption per i.hp.-hr. That of the duplex pump has been assumed to be 100 lb. With this steam rate the pump must abstract 2,545 B.t.u. from each 100 lb. of steam, or 25 B.t.u. from each pound. The total heat of the exhaust steam must then be 1,195 — 25 = 1,170 B.t.u., which is 1,170 — 1,156 = 14 B.t.u. more than that of saturated steam at this pressure. Taking 0.47 B.t.u. as the specific heat of superheated steam, the exhaust steam must be superheated 14 ÷ 0.47 = 30 degrees.

Exhaust of Slide-Valve Engine

In the same way, assuming that the slide-valve engine has a steam rate of 45 lb. per i.hp.-hr., each pound must abstract 2,545 ÷ 45 = 56 B.t.u., making the total heat of the exhaust steam 1,195 — 56 = 1,139 B.t.u. This steam is therefore wet, since its total heat is less than 1,156. The heat of the liquid of dry saturated steam at 20 lb. absolute is 196 B.t.u., and the heat of evaporation 960 B.t.u. Now, wet steam contains all the heat of the liquid, but only that portion of the heat of evaporation corresponding to the percentage of dryness; that is, to the percentage that is actually steam. Subtracting 196 B.t.u. (the heat of the liquid) from 1,139 gives 943 B.t.u. as the heat representing actual evaporation. Since it would take 960 B.t.u. to completely evaporate one pound, the fact that but 943 B.t.u. are so used shows that the fraction evaporated is $\frac{943}{960} = 0.98$, or 98 per cent. The same method is used to figure the quality of the exhaust steam from the other engines.

N. E. L. A. Holds Largest Convention and Exhibition in Its History

Forty-Seventh General Convention Held in Atlantic City, with Record Attendance and 135 Companies Exhibiting a Great Variety of Equipment Used in the Production and Utilization of Power

WITH a record attendance at the convention as well as at the various meetings, the forty-seventh annual convention of the National Electric Light Association was held last week on the Million Dollar Pier in Atlantic City. The previous record for number of exhibitors was 98, so that this year's figure of 135 excels previous figures by a large margin. In this exhibit was practically every kind of equipment that the central-station industry is interested in, from apparatus used in the production of power to all kinds of devices for its industrial and domestic use.

Three technical sessions were held, at the first of which was presented the various technical committee reports with H. P. Liversidge, chairman, Technical National Section, presiding. One of the disappointing features of this year's meeting, which had a larger attendance than any similar session of previous years, was the absence of any discussion on the reports. This is particularly true of the Prime Movers Report which in past years has been one of the big events.

Reporting for the Prime Movers' Committee, Chairman Nicholas Stahl pointed out the change in procedure whereby the report is now issued in serial form over the entire year instead of one large volume as heretofore. There are at work twenty-eight subcommittees, of which eleven have already issued reports. Five are engaged in special investigations, and the remaining twelve will issue reports later in the year.

In briefly reviewing the activities in the field throughout the year, Mr. Stahl noted the recent application of air preheaters to American practice, the introduction of water-cooled furnaces, the employment of higher pressures and temperatures and the notable increase in powdered-fuel installations. During the last year these total, in square feet of boiler-heating surface sold, 70 per cent of that sold during the preceding seven years. The problem of furnace maintenance with powdered coal is now being satisfactorily handled through the employment of ventilated or cooled walls, water screens, radiant superheaters, etc. In one recent large installation the ash from the powdered coal is being arrested by means of electric precipitators.

A careful check during the year on 106 large turbo-generators has indicated decided improvement in performance except in the condensers. Turbine lubrication is still forming the subject of intensive study, which is now taking the form of a compilation of laboratory and field-service data. By the employment of a sludge precipitator an attempt is being made to reduce laboratory work to actual service conditions.

With reference to Diesel engines the chairman noted a greater tendency toward the two-stroke-cycle type and a willingness on the part of builders to quote on large sizes.

Serial reports on station piping and liquid and gaseous fuels were recently issued. Some of the high points of these follow:

Station Piping

During the last year the principal work of a subcommittee of the American Engineering Standards Committee on station piping has been in connection with the proposed standardization for valves, flanges and fittings for superheated steam at 250 lb. working pressure and above.

Standardization is being attempted for steam temperatures of 750 deg. F. at operating gage pressures of 250, 400, 600, 900, 1,350, 2,000 and 3,200 lb. per square inch.

The 250- and 400-lb. steam standards will be based on the American Standard 250-lb. cast-iron drilling and bolt circle with modifications in thickness and face-to-face dimensions for the 400-lb. standard. The 600-lb. steam standard will be based on the 800-lb. hydraulic standard modified, and the 900 lb. on the 1,200-lb. hydraulic standard modified.

Investigations of bolts were carried far enough to indicate that serious consideration should be given to this feature of power-station construction inasmuch as the majority of operating companies have had very unsatisfactory results when using the ordinary commercial bolt for high pressures and high temperatures. The reports received from plants operating at pressures above 250 lb. at a temperature of 600 deg. F. have indicated that after being in service for a year or so and sometimes only a few months, the ordinary bolts become brittle, the heads sometimes snapping upon being struck with a hammer. The turbine and valve manufacturers having recognized this some time ago are now using special alloy steel bolts for all connections subjected to high temperatures. Where special alloy steel is used for bolts, they are usually made in the form of studs and the nuts are cold-punched.

A typical specification for special alloy steel studs provides for chrome-nickel steel having a minimum yield point of 50,000 lb. per sq.in.; minimum elongation in 2 in., 25 per cent; and minimum reduction of area in 2 in., 50 per cent.

Liquid and Gaseous Fuels

The situation in the fuel-oil market which developed in 1922, because domestic production outran consumption, continues to exist in a much greater degree on account of the flush production in California. While fuel oil at the present time is plentiful and prices low, the committee warns that there is no indication that this condition is stable.

Mechanical burners are gradually being improved in detail, and impellers of special heat-resisting metal are giving longer service than heretofore. One of the most important questions in connection with mechanical-burner installations is that of furnace design to obtain a longer life for the brickwork. Floors that are laid directly upon foundations that have no basement or space underneath suffer particularly. The firebrick is often melted, insulating material destroyed and in some cases the concrete base upon which the floor was laid is vitrified. To avoid this, it is necessary to provide an air space under the floor.

Air preheaters in connection with boilers fired with mechanical oil burners seem to offer attractive possibilities. The mechanical burner is easily adapted to forced draft, and the passage of preheated air should offer no difficulties. As yet no installation of separate preheaters has been reported, although one company is putting in a trial installation.

Test data published in previous reports have shown that for a given type of boiler the most efficient rate for combustion per unit of volume is constant and recent tests indicate that the relation between the rate of combustion per unit of volume and boiler efficiency is likewise constant for any given type of boiler. A question of importance is the maximum quantity of oil that can be fired per unit of volume without decreasing furnace efficiency. Tests by one company indicate about 2½ lb. of oil per cubic foot per hour as the maximum that can be fired before a decrease occurs in furnace efficiency.

Gas as an atomizing agent for fuel oil is being tried out at the Waco plant of the Texas Power & Light Co. The saving being effected by the use of gas as an atomizing agent (with its cost approximately the same as oil) is evident when it is considered that at least 1½ per cent of the total steam generated would be required for atomizing and that the heat required to raise this steam to a temperature of the escaping gases must be robbed from the heat generated in the furnace.

Electrical Apparatus Committee Report

Although this year's report is not as large as formerly, a great deal has been accomplished and the committee is preparing and expects to issue serial reports on the following subjects: Alternating-Current Low-Voltage Net-

works; Alternating-Current Substation Design; Substation Grounding Methods and Practice; Electrically Driven Auxiliaries for Steam Generating Stations; and Power-Factor Improvement. To these should be added the Relay Handbook, which is completed and is expected to be ready for distribution by December of this year.

Complete agreement has been reached with the manufacturers and the A.I.E.E. Protective Devices Committee on the new definitions of duty cycle for oil circuit breakers, which have been under discussion during the last two years. These definitions are given in full. Some interesting information on interrupting ability of power fuses from tests made by member companies is included.

According to this year's report, experience with temperature-indicating devices has demonstrated their value in permitting smaller transformer capacity per kilovolt-ampere of peak load, reducing transformer failures and generally improving the quality of service. Advocates of a single standard of polarity for all transformers have again urged that the present additive polarity of distribution transforms 200 kva. and smaller whose high-voltage ratings are less than 7,500 volts, be changed to subtractive. Another general canvass, however, indicates a preference for the present standards. Development work on the Pacific Coast in air-cooling of circulating oil for large transformers, to overcome difficulties of water-cooling, is described.

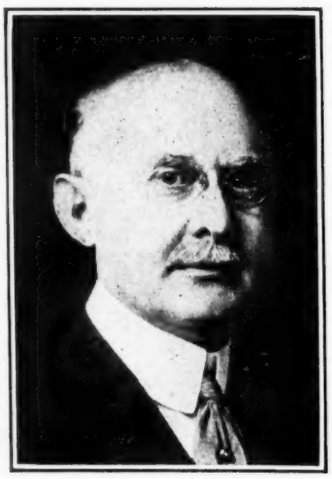
Cleaning Air for Air-Blast Transformers

In response to the inquiry from a member company, data were collected by the committee covering methods in use for cleaning the air delivered to air-blast transformers. Of nineteen companies furnishing data, only nine were using air-blast transformers. Of these, five report the use of air washers; one used cheesecloth in the intake, changed at specified intervals; one used large-mesh screens, and two did not find cleaning apparatus necessary. Of the five companies that used washers, two reported transformer failures directly or indirectly attributable to moisture from the washer, and two reported that the washer did not clean the air satisfactorily.

The information collected indicated that there is a general tendency to change from washers to dry filters. One company reports that where it is not necessary to cool the air for transformers, the chemically coated air filter is much superior to the water-spray type. Tests show that 97 to 98 per cent of the dirt is caught by the filter. The opinion is expressed that the water-spray filter takes up valuable space and certain parts deteriorate so as to call for replacement within four or five years. The maintenance of such a washer is high and it creates at all times a wet and sloppy condition not in accord with the usual housekeeping conditions in an electrical substation.

Another company is solving the problem by a special design of transformer which makes the windings less inflammable and readily cleaned. This company is, however, providing space for the installation of a filter or washer to clean the air for the entire building if this is ever found necessary.

The committee reports that considerable interest has been manifested in the possibility of development of couplings for turbo-generators which could be rapidly disconnected in case of turbine trouble, thus permitting the use of the generator as a synchronous condenser for power-factor correction while the turbine was out of commission. All four-bearing turbo-generator units can be disconnected in from three to four hours, but it is necessary to arrange for lubrication and starting of the generator. It has been suggested to manufacturers that suitable means be made available to split the oil system easily on turbo-generators in order to be able to run the generator with the main coupling disconnected. It is pointed out that certain three-bearing machines cannot be operated in this manner.



Walter H. Johnson
Retiring President

Unfavorable experience with water-spray air washers has been reported by two larger companies due to low temperature. The trouble was due to the freezing up of the eliminator plates, resulting in the cutting off of the air supply to the generators. In one case the armature on the turbo-generator was destroyed. These cases focus attention upon the necessity of reliable cooling systems.

Hydraulic Committee Report

A large part (95 pages) of the Hydraulic Power Committee report is devoted to data relating to the design, construction and operating practice of control and outlet works for diversion dams and storage reservoirs throughout the United States and Canada. The report goes into detail concerning a number of typical installations and covers not only the main structures, but also the numerous items of auxiliary equipment.

As a means of obtaining concrete facts regarding pitting of hydraulic turbine runners, letters were sent to about forty companies operating water-power plants in this country and Canada, who represented about two-thirds of the total developed water powers, requesting information on the different wheel settings in order that the specific speed and the total draft head on the wheels might be figured. The work of the committee is not yet finished, but data on about seventy wheels are given in the report.

Although the statements made are only tentative, the investigation so far seems to indicate that the primary cause of pitting of hydraulic turbines is high draft head resulting in nearly complete vacuums on the surfaces of the runners. Pitting occurs when the main stream of water pulls away from the surface of the wheel and where the vacuum draws from the passing stream a spray of water and oxygen released by the draft head, the oxygen becoming highly concentrated because of the violent eddies created. The opinion is expressed that pitting may be avoided by lower wheel settings or by any other method that decreases the draft head. Pitting on existing runners may be minimized by building up the affected areas by electric-arc welding, using a metal that resists corrosion better than the original metal.

Present Status of Draft Tubes

In the section of the report dealing with the present status of draft-tube development, attention is called to the field covered by tests on draft tubes being limited to specific speeds of 70, 85 and 90. It is suggested that a comparison of draft-tube efficiencies for the various specific speeds shows that research work of a comparative nature is needed to cover the full range of specific speeds in common use.

It is stated in the report that no doubt many comparative tests on draft tubes for some specific installation have been made by operating companies, but the data are not available for the use of the engineering profession in general. Should this information be published, it would eliminate a duplication of work and result in a considerable saving in time and money, and make possible further research by operating companies, either individually or collectively. The true value of experimental work on models will be gained by thorough tests on the plant after being put in operation. This is of great consequence if two types of tubes are selected and operated side by side in the same power house so that hydraulic conditions are as nearly as possible the same.

Constructive criticism of hydraulic-turbine lubricating methods forms another section of the report, in which it is attempted to point out defects in existing lubricating methods and suggest means for better and safer lubrication. It appears to be the consensus of opinion among operating engineers that there are still ample opportunities for improvement in lubricating methods.

Inspection and Maintenance Methods

The section of the report dealing with inspection and maintenance methods for hydro-electric plants includes several charts and forms for this class of work. The opinion is expressed that the or-

ganization of maintenance work cannot be standardized. It must depend on the number and size, and especially the relative size, of plants, their relative location and accessibility, their location with relation to load centers or distributing points and the central office, the company's personnel, and many other factors. In nearly every case the existing organization has come about by evolution, the scheme often being adapted to the personnel rather than the reverse. In maintenance, as in other departments, probably few companies are organized as they would be if a fresh start were made in the present state of growth.

The committee finds that there is a surprising lack of agreement as to the method of scheduling or planning major overhauling or maintenance. The one rule on which there is agreement is that such work is done so far as possible during the low flow season or period, if any, or if there is no such time, then during the season of least load demand.

In the section on waterwheel testing it is stated that if the waste of water at maximum efficiency is considered as zero, it is probably true that for each 1 per cent of load increase above this point the waste of water is not less than 2 or 3 per cent. In two large modern Francis wheels of different capacities and speeds at a load 5 per cent above the most efficient load, the average waste is 12 per cent; at 10 per cent, the waste is 25 per cent; and at 15 per cent, the waste is 45 per cent. For all ordinary operation in practically every plant there is a real loss in loading a wheel beyond its most efficient point. This is true not only from the viewpoint of water waste, but on account of other disadvantages, such as regulation and runner pitting and wear.

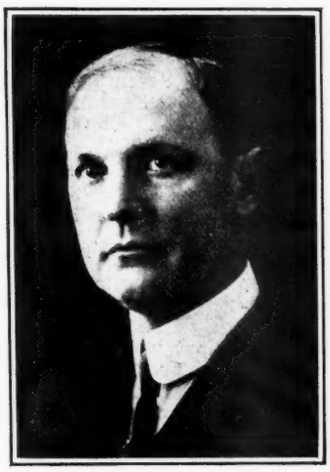
In view of the penstock failures that have occurred during the last four or five years, the paper, "Fall in Pressure in Hydraulic Turbine Penstock Due to Acceleration of Flow," by S. Logan Kerr, forms an interesting part of the report. An abstract of this paper will appear in an early issue.

Secretary Hoover on Interconnection

At the Wednesday evening meeting one of the notable features was an address on interconnection by Secretary Herbert Hoover, delivered while sitting at his desk in Washington, D. C., and transmitted to the convention by radio. The secretary discussed not only the subject of interconnection as it applies to power systems, but also what it has accomplished in the field of communication. "We have," said Mr. Hoover, "outdistanced all the world in our electrical development up to now. Today we have 27,000 telegraph stations, over 15,000,000 telephones, over 600 radio broadcasting stations, over 3,000,000 receiving sets with possibly 15,000,000 listeners; 9,000,000 homes are wired for lights; we have the capacity to generate over 27,000,000 electrical horsepower. The American wage earner has at his elbow 50 per cent more power than any of his competitors. In consequence, his product is greater, his wage higher, and his physical strain is less than any other."

Speaking of future power developments, the speaker said that, "the next great step here also is interconnection. For interconnection is now the road of our great electrical march to more economical expansion. Indeed we have here before us a step of progress which will ramify into every field of our economic life.

"We have in the United States today about 6,000 separate power and lighting systems. To take advantage of these new forces we need interconnection of these isolated systems over large geographical areas so as to provide a sort of great reservoir into which these larger streams of power may be poured from central plants and from our greater water powers. Some interconnection has taken place, but in this large vision of our more recent engineering advances less than 10 per cent of the systems are interconnected. We have many gains to make through this wider interconnection and central generation. From them we shall secure cheaper production costs, in greater reliability, better utilization and consequent conservation of our coal supplies and larger utilization of our available water power."



Franklin T. Griffith
President-Elect

Governmental Regulation

Concerning governmental regulation Mr. Hoover pointed out that "all this gigantic development raises hosts of problems in governmental relations. If we would secure these great benefits, we need a wise statesmanship. From the very nature of the industry it is one where there must be a large measure of public control. Yet to draw the fundamental principles upon which these relationships should be based is no easy task. They reach deep into our whole social conceptions."

"American business," said the Secretary, "needs a lifting purpose greater than the struggle of materialism. It does not lie in some visionary and emotional crusade. It lies in the higher pitch of economic life and finer regard for the rights of others. Through the organization of great tools in our economic life so that they may produce happier individual lives, more secure in employment, wider in possibilities of comfort and enjoyment, larger in possibilities of intellectual life."

Governor Pinchot on Giant Power

An outstanding feature of the Wednesday morning session was the address by Governor Pinchot on "Giant Power." This he differentiated from "superpower" by explaining that while the latter had for its principal object the interconnection of existing systems and exchange of surplus power, the former embraced mine-mouth plants, water power, byproduct recovery, transmission systems, interconnection for actual exchange of power and distribution over the widest possible areas with a view not only to rendering service to rural districts and the greatest number at the lowest rates, but to aid in decentralizing the already too congested industrial centers. Such a system should know no state boundries and the government should remove all obstacles to such plans under such safeguards as will respect public rights.

The Governor referred to the growth in the use of electricity and to the ever-increasing economies in power production which were reflected in the comparatively stationary or in some cases reduced rates while other commodities had risen. He complimented the utility companies of Pennsylvania for their support of the existing state laws and their co-operation in his attempt to work out the Giant Power idea. Pennsylvania, he characterized as the "Keystone" state in power resources, with coal enough to furnish one million horsepower for a thousand years. Moreover, it has the largest percentage of stream development.

Election of Officers

The convention unanimously elected the officers proposed by the nominating committee as follows: President, Frank T. Griffith, pres. Portland Railway, Light & Power Co., Portland, Ore.; first vice-pres., James E. Davidson, vice-pres. & gen. mgr. Nebraska Power Co., Omaha, Neb.; second vice-pres., Robert F. Pack, vice-pres. & gen. mgr. Northern States Power Co., Minneapolis, Minn.; third vice-pres., Howard T. Sands, vice-pres. Chas. H. Tenny & Co., Boston, Mass.; fourth vice-pres., P. S. Arkwright, pres. Georgia Railway & Power Co., Atlanta, Ga.; treas., W. A. Jones, Henry L. Doherty & Co., New York. Seven members at large of the executive committee were elected: Past-President Walter H. Johnson, vice-pres. Philadelphia Electric Co.; H. C. Abell, Electric Bond & Share Co., New York City; I. E. Moultrop, Edison Illuminating Co., Boston, Mass.; W. E. Robertson, Cataract Electric Co., Buffalo, N. Y.; J. R. Strong, Tucker Elec. Co., New York; H. M. Edward, New York Edison Co.; and Gerard Swoope, General Electric Co. Five were re-elected: E. M. Herr, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.; T. A. Kenney, Hodenpyl, Hardy & Co., New York City; W. A. Layman, Wagner Electric Corp., St. Louis; Harry Reid, Interstate Public Service Co., Indianapolis, Ind., and E. W. Lloyd, of Chicago.

Recent Publications

Steam Heating. A manual of practical data. Compiled by the General Engineering Committee of Warren Webster & Co. Revised edition. Published by Warren Webster & Co., Camden, N. J., 1923. Cloth; 8 x 10¼ in.; 367 pages; numerous illustrations and tables. Price, $3.25 net.

The first printing of this edition was reviewed in the July 11, 1922, issue of *Power*, the present revision covering practically the same ground. For those who have not seen the previous review, it may be said that this is a valuable reference book covering almost every phase of steam heating. The first 150 pages deal with the subject of heating in general, with unusually complete data on the various problems of design. A second section deals with the specialties of the Webster system of steam heating, while the last 40 pages are given over to useful miscellaneous information of interest to engineers.

Wiring for Light and Power. By Terrell Croft. Published by McGraw-Hill Book Co., Inc., New York City, 1924. Semi-flexible binding; 5x7½ in.; 551 pages; 552 illustrations. Price $3.

The 1923 edition of the National Electrical Code is not only completely rearranged, but also contains many important changes from prior regulations. To meet this change the fourth edition of "Wiring for Light and Power" has been presented. This new edition has been rearranged and rewritten to conform to the 1923 code. The purpose of this book is to provide explanations, elaborations and illustrations for those sections of the National Electrical Code to which it is necessary to refer most frequently. The book has incorporated in it the code regulations. Each ruling or regulation is followed by explanations and illustrations showing how it is applied or interpreted. One of the valuable features of the book is the 552 illustrations showing how electrical installations are made to conform to the Code. The index occupies 20 pages and should be an important asset to the work in making the information presented easily available.

Practical Calculus for Home Study. By Claude Irwin Palmer. Published by The McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth; 5x8 in., 437 pages. Price, $3.

Home-study books dealing with arithmetic, algebra and trigonometry have long been available, but those who had mastered these subjects through home study were generally obliged to use the regular college textbooks if they desired to study calculus. No one could be better fitted to remedy this situation than Claude I. Palmer, who has had much experience in meeting the special needs of the home student. The author does not call the book "Calculus Made Easy," the reason doubtless being that there is no royal road to this subject. Yet calculus can doubtless be mastered at home by one who is fairly well grounded in algebra, geometry and trigonometry. While avoiding the stilted "textbook" presentation and emphasizing the many practical applications, the book does not depart from sound mathematical fundamentals. Both differential and integral calculus are covered. Many problems, the answers to which are given in the back, increase the usefulness of this book. There are also extensive tables of integration formulas, trigonometrical formulas and logarithms.

Tulley's Handbook. By Henry C. Tulley, engineer and member Board of Engineers, St. Louis. Seventh edition, fully revised and enlarged by James F. Hobart. In three volumes. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York, and 6 and 8 Bouverie St., London, E. C. 4; 1924. Cloth; 6x8¼ in.; illustrated. Price, $7.50.

The work is profusely illustrated, well indexed and is made up of 30 sections, each of which contains an analysis of the contents on the first page. The original Tulley handbook was written for the practical man who was fitting himself to become chief engineer. Mr. Tulley himself had climbed the ladder. He had found out what the practical man needed and had compiled it patiently and thoroughly.

It takes more than engineering knowledge in order to succeed. In the first section, entitled "In Charge of a Steam Plant," Mr. Tulley has put down the various things that a man must look out for when taking over a plant. Thus he details the first duty of an engineer; shows what he should watch and how; how economy should be obtained; takes up the matter of fuel bills, boiler conditions, leaks and a large number of such details that are not touched upon in many handbooks of engineering.

Mr. Hobart, in revising this book, has kept this idea to the front. Mr. Tulley's advice, based on thought and experience, is everywhere apparent. His own explanations of things that go on, in a language which the practical man can understand, appear throughout the book.

The engineer of the small plant nowadays must know almost everything, as some might be inclined to express it. The field now covered by direct-current motors, for instance, is much more complicated than that represented by the direct-current motors of a few years ago. The various troubles encountered and their remedies are here detailed. Boiler-plant instruments have been refined to a remarkable degree, and their maintenance is a special study in itself. Feed-water treating, which removes the dissolved oxygen, is another delicate matter.

In this way the field of the power plant engineer is now full of complications. In order to supply a working knowledge of the entire field, the seventh edition has been considerably increased in size. It now appears in three smaller volumes for greater convenience.

Volume 1 contains ten sections: In Charge of a Steam Plant; Steam Boilers; Boiler Chimneys, Furnaces, Stokers; Fuels; Coal Handling and Ash Disposal; Chimney-Gas Analysis; Combustion Control; Economizers, Superheaters, Feed-Water Heaters; Filters, Traps, Separators; and Condensers.

The remaining volumes include Direct-Current Motors, Alternating-Current Generators and Motors, Lamps, Circuits, Transformers, Mechanical Refrigerating, Elevators, Meters for Water, Steam, Air, Gas and Coal; Air Compressor and Air Lift; Air Conditioning, Heating and Ventilating, Internal-Combustion Engines; Handy Reference Tables, Steam Turbines, Fittings, and many other subjects equally valuable.

Steam Boilers, Their Auxiliaries and Accessories (Die Dampfkessel, nebst Zubehoerteilen und Hilfseinrichtungen). By R. Spalckhaver, F. Schneider and A. Ruester. Second edition, 1924. Published in German by Julius Springer, Berlin, Germany. Cloth, 9¼x12¼ in., 477 pages; 810 illustrations; 112 tabulations, Price, $9.75.

This book is doubtless one of the most complete manuals on steam boilers ever published. Although it is confined almost entirely to German boiler designs, it is replete with formulas and practical boiler information that are of great value to the designer, manufacturer, boiler-operating superintendent and advanced student. The many types of boilers, stokers and their accessories bear witness to the effort and progress made by German engineers to obtain the utmost in economy.

The opening chapters on heat, steam, the fundamental principles of thermodynamics, fuels, the theory of combustion and furnace temperature are commendable for their clear and systematic presentation. Translated into English, they would make an excellent reference work. The text on the firing of solid fuels includes descriptions of grates, overfeed, underfeed, cascade and traveling grate stokers, together with methods for obtaining sufficient draft to burn inferior fuels. The popularity of the overfeed stoker is suggested by the large number of designs that are illustrated. Also the absence of shaking and dumping grates and hand stokers is notable. Pulverized fuel is briefly covered, with reference to the economies obtained in America. Oil-burning systems receive but scant attention, while only a few representative types of gas burners for coke oven, blast furnace and producer gas firing are mentioned.

Very complete descriptions of German boiler types, with many illustrations and details are given. The predominance of the internally fired flue boiler and its combination with a superimposed return-tubular boiler is evident. Both water-tube and fire-tube boilers in stationary, locomotive and marine boilers are given considerable space. Water-tube boilers with extra large water storage for operation under extreme load fluctuation are remarkable for their odd proportions and in-

ternal connections to improve the circulation. A number of waste-heat boiler designs and their application to Diesel and gas engine plants are illustrated. Electrically heated boilers and a description of the systems of steam storage conclude this section.

The chapters on superheaters and the methods of regulating the final steam temperature by damper control, mixing with saturated steam and conducting the superheated steam through a pipe which passes through the water space of the boiler, together with the method for calculating the amount of superheater surface required, are of decided interest. Economizers are similarly though not so extensively covered.

Some excellent data on chimneys and boiler settings are made available. Boiler design, materials employed in construction, machine tools employed in manufacturing, shop routing, cost estimating are treated in a comprehensive manner and give a good insight to German boiler-shop practice. Boiler-plant layout, ventilation of boiler houses, coal handling and boiler control receive less attention than they deserve. Feed-water treatments, grease extraction, evaporators and deaëration processes are reviewed. Some helpful suggestions may be obtained in the chapters on practical boiler operation and boiler repairs.

The book concludes with the German Boiler-Test Code and laws governing the operation of steam boilers.

A.S.M.E. Boiler Construction Code. Formulated by the Boiler Code Committee of the American Society of Mechanical Engineers. Published by the society at 29 West 39th St., New York City. Size, 5¼ x 7¾ in.; 198 pages; illustrated. Price, $2.50.

In 1911 the American Society of Mechanical Engineers appointed a committee "to formulate standard specifications for the construction of steam boilers and other pressure vessels, and for their care in service." Its first Code was issued in 1914, and the committee, comprising the most eminent specialists in boiler practice in this country, has met monthly ever since to interpret the Code and adjust it to the requirements of a rapidly changing practice. It has become the basic law of seventeen states, fifteen cities and the Hawaiian Islands.

This is the second revision. In addition to many changes in detail that the four years of practical application and progress in the art since the last revision have shown to be advisable, the arrangement has been simplified and the section dealing with existing installations relegated to the appendix. The province of the committee is to define a safe boiler and tell how it should be made, leaving to those charged with the administration of the law to decide which of existing boilers shall be allowed to continue to run, and under what conditions.

Material specifications have been consolidated into a separate section applicable to any of the several codes.

Of the Construction Code proper there are 75 pages, containing 334 numbered paragraphs. The material has been conveniently segregated into groups treating of Selection of Materials, Construction and Maximum Allowable Working Pressures, Ligaments, Domes, Dished Heads, Braced and Stayed Surfaces, Furnaces, Flues and Tubes, Riveting, Calking, Manholes, Washout Openings, Threaded Openings, Safety Valves, Water and Steam Gages, Fittings and Appliances, Setting, Hydrostatic Tests and Stamping.

It is the latest word in boiler practice, and the only, other than local, authority recognized in professional and legal practice in the United States.

Our American System of Weights and Measures—Why We Should Keep It. Published for gratuitous distribution by the American Institute of Weights and Measures, 115 Broadway, New York. Paper covers; 5x8 in.; 64 pages; illustrated.

The American Institute of Weights and Measures is organized for "the promotion of wise legislation, for the conservation and improvement of our English units of weight and measure and opposition to hasty and ill-considered legislation, involving changes from these standards."

This pamphlet is written as a protest against legislation to force the adoption of the metric system and as an appeal "to stand resolutely for the maintenance of our customary (English) system."

If every established usage or system had such a determined organization behind it, the diversified practices of the world would become frozen and crystallized, each in its own circle of users, and eventual uniformity be hopeless to contemplate.

Popular Research Narratives. Collected by the Engineering Foundation, 29 West 39th St., New York City. Published by Williams & Wilkins Co., Baltimore, Md., 1924. Cloth, 5x7½ in.; 152 pages. Price, 50 cents.

Fifty fascinating, five-minute tales of recearch, invention and discovery in science and engineering, directly from the "men who did it," are here presented in such simple language that young and old, engineer and layman, will be entertained and instructed by reading them. The narratives, first issued in leaflet form by the Engineering Foundation, are intended to promote interest, by intelligent citizens, in research. As scientists and engineers habitually write in awe-inspiring technical language, they often obscure the many wonderful achievements in science and engineering from those not versed in this phraseology. These tales are aimed to overcome this obstacle. A portrait drawing of Ambrose Swasey, whose generosity made possible the Engineering Foundation, adds to the charm of the volume.

Modern Engineering For Power Plant Operators—By W. H. Wakeman. Size 3 x 5½ in.; 392 pages; 120 illustrations. In this little book, which is being distributed by the New York Belting & Packing Co., the author reviews the general principles of power-plant engineering and the different types of equipment now in common use, pointing out the relative merits of each type. A portion of the book is devoted to questions and answers relative to boiler feeding and conducting a boiler test.

Transformer Standards of the Electric Power Club. Third edition, January, 1924. Paper; 37 pages. To be obtained from Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio.

Power Test Code for Reciprocating Steam Engines—Published by the American Society of Mechanical Engineers, 29 West 39 St., New York City. Price, 45c. to members and 50c. to nonmembers.

The American Engineering Standards Committee has just issued a small book entitled "Standardization, What it is Doing for Industry," which can be had by writing to their office, 29 West 39th St., New York City.

The Heating and Ventilating Magazine Co., 1123 Broadway, New York City, has recently published eight articles on "House Heating with Fuel Oil." Reprints of them can be had from the magazine for 50 cents postpaid.

International Railway Fuel Association—Proceedings of the Fifteenth Annual Convention. Locomotive Publishing Co., Ltd., 3 Amen Corner, Paternoster Row, London, E.C., England. Cloth, 6x9 inches; 386 pages. Price, $3.

Elektrische Temperature-Messgeräte (Electrical Temperature Measuring). By Dr. Georg Keinath. Published by R. Oldenbourg, Munchen and Berlin, Germany. Printed in German. Paper; 6½x9½ in.; 270 pages; 249 illustrations. Price, $1.

United States Government Specifications for Lubricants and Liquid Fuels and Methods for Testing. Federal Specification Board Standard Specification No. 2c, Technical Paper 323A. Published by the Bureau of Mines. Revised March 18, 1924. Price, 15 cents from Superintendent of Documents, Government Printing Office, Washington, D. C.

The Utilization of Water Power in Canada in Relation to Coal Production, Importation and Consumption. — The Dominion Water Power Branch of the Department of the Interior of Canada has recently prepared an analysis of the use of water power in Canada for industrial purposes, effected in the importation and consumption of coal due to the use of water power. Copies of this bulletin may be obtained free of charge on application to the Director of Water Power, Ottawa, Canada.

Standards, European — Copies of European mechanical engineering standards issued during 1923, can be procured from the American Engineering Standards Committee for a nominal charge by applying to the committee at their office 29 West 39th St., New York City. Standards that will interest readers of *Power* are:

Austria—Shafting, ONIG M6405 and M6406 standards for bearing supports; Germany—Shafting, Din Buch 6 containing standards dealing with mechanical power transmission and shafting; Germany—Ball Bearings, DIN 612-614, 622-624 gives standard ball bearings.

Motion to Report Ford Bid to Senate Is Rejected by Committee

Public Ownership Not Opposed Now by Power Companies—Senate Vote Expected During This Session of Congress

BY A VOTE of 10 to 6, the Senate Committee on Agriculture on May 21 refused to allow the bill embodying Henry Ford's offer for the Muscle Shoals properties of the government to go on the Senate calendar, even with an unfavorable report. No motion proposing to report the Ford bill favorably was made at this session of the committee. Had such a motion been made, it probably would have been supported by not to exceed four votes. The objective of the proponents of the Ford bill at this hearing was to get the measure on the Senate calendar. They recognized that a favorable report could not be obtained, so the only motion made was that to report the bill unfavorably. On failing to get the Ford bill out of committee, even with an unfavorable report it then was moved to report Chairman Norris' government-control bill. This would have been of advantage to the Ford supporters, as the passage by the Senate of this substitute for the Ford bill would have thrown the legislation into conference. In this way many of the features of the Ford bill could be embodied in the conferees' bill. This proposal, however, was voted down 11 to 6. A motion to close the hearings immediately was lost overwhelmingly, but by a vote of 10 to 6 the committee agreed to close the public hearings on May 26 and to consider, in executive session, on the day following such final action as the committee may take.

The majority of the committee, it is believed, feels that in view of the government's $200,000,000 investment at Muscle Shoals the best course to pursue is government operation of the dam, and its power house. In that connection, it has been suggested that contracts for power, for a time at least, be for relatively short periods until actual operation may have demonstrated the terms and conditions under which the public's interest will be served best.

Senator Heflin, of Alabama, declares that he will find a way to secure a vote in the Senate on the Ford bill. He probably intends to propose it as a rider on some other bill.

A vote in the Senate on the disposition of Muscle Shoals appears certain before the expected summer adjournment of Congress, but whether this will be a direct vote on the Ford offer or on another plan remains uncertain. Ford advocates are most active in pressing for a vote, but this action is not opposed by those Senators who do not favor the Ford bid.

The various proposals for disposition of the government's works at Muscle Shoals have been explained before the Senate committee on agriculture, which also has called before it government officials in an effort to complete the record in the case.

E. A. Yates, general manager of the Alabama Power Co., speaking for the associated Southern power companies which have submitted a bid for the Muscle Shoals developments, proved one of the most interesting witnesses to the committee members and was kept before them several days longer than he had expected.

In reply to questions from Chairman Norris and Senator Kendrick, Mr. Yates disclosed that the Southern power companies are not inimicable to government control and operation of Muscle Shoals, but, on the contrary, viewed this suggestion, in the words of Mr. Yates, as "in some respects preferable to private operation." The power companies, Mr. Yates said, would offer to buy electricity from the government, in such event, and would distribute it over a superpower system. Mr. Yates further told the committee that the Alabama Power Co. would be willing to sell to the government at a fair price the site necessary for the construction of Dam No. 3. He recalled that the company has sold the site for Dam No. 2 to the government for $1 during the war. Unless the power from Muscle Shoals is distributed throughout the Southeastern States, Mr. Yates said, the shortage in that territory within 15 years of development of use would be tremendous.

Attorney General to Study Issuance of Trade Data

Some clarification of the subject of trade associations and statistics is in prospect as a result of the change in attorneys general. Mr. Daugherty gave this controversy very little personal attention, but he was willing to stand behind certain of his assistants who have assumed what is regarded both in and out of government circles as an unreasonable attitude. It is believed that Mr. Stone, the new Attorney General, will insist on determining this policy for himself. It is known positively that he has not given study to the subject, but he recognizes the importance of having some decision.

Hydraulic Laboratory Advocated

Further testimony is to be taken by the Senate Committee on Commerce in connection with legislation proposing the establishment of a National Hydraulic Laboratory. Commerce Secretary Hoover has been asked to testify as to the general achievements of research work. The thought of the committee, as a result of testimony previously taken, is that the problems of river training should be approached from a scientific angle as well as from the application of practical experience.

General Harry Taylor, the incoming Chief of Engineers, N. C. Grover, chief hydraulic engineer of the Geological Survey, and Elwood Mead, Commissioner of Reclamation, are among those who will testify.

Indiana Interlinking Its Power Systems

Superpower is an established fact in Indiana, according to Harry Reid, head of the Interstate Public Service Co. and chairman of the Indiana Committee on Public Utility Information, according to press reports.

"Indiana power companies," says Mr. Reid, "are spending on projects under way last year and this year, in the neighborhood of $50,000,000 to make superpower a reality. By the end of this year it is likely that no industrial community of any consequence in the State will be isolated as regards power facilities."

New developments include several that are noteworthy. One Indianapolis company, serving practically that city only, is spending $3,000,000 to increase its generating capacity 30,000 kw. Another is building a power plant on the Wabash River in the coal fields, and erecting a transmission system to cover the central western part of the state. A third with a big hydro-electric generating station on the Tippecanoe River, in the northwest part of Indiana, also is tying up a number of communities.

The same interests are planning a tremendous power plant on the Ohio River, near Louisville, and another in the Calumet region, near Hammond and Gary. The St. Joe Valley, including the big industrial centers. South Bend, Goshen, Elkhart, and Mishawaka will see a new $7,500,000 plant in operation in a few months, in addition to existing power facilities. More than $1,000,000 is being spent in the Fort Wayne territory to improve power facilities, and Evansville, which is the only considerable industrial community in the lower Wabash and Ohio River territory, is witnessing the investment of $500,000.

Public-Utility Power Plants Production for March

The average daily production of electricity by public-utility power plants of the United States in March was 160,700,000 kw.-hr., about 3½ per cent less than the average for the month of February. This decline probably was due in part to seasonal effect.

These plants consumed 3,250,947 net tons of coal during March, according to a report just issued by the Geological Survey. This compares with 3,330,107 tons consumed in February and 3,664,258 tons in January. Fuel oil consumed by utility plants in March totaled 1,538,178 bbl., compared with 1,544,927 bbl. in Feburary and 1,618,591 bbl. in January.

A Free School of Oil Burning Started

Men in charge of the operation of oil-burning equipment realize that the burning of boiler oil efficiently and economically is a science and not merely the opening and closing of a valve. Efficiency and economy in operating depends considerably on intelligent handling of the equipment.

In order to train men in this comparatively new science of oil burning and to obtain the best results from operation, the Todd Shipyards Corporation has established at the plant of the Todd Oil Burner & Engineering Corp., 742 East Twelfth St., New York City, a free school under the direction of A. L. Wernert for the instruction of engineers, oilers, water-tenders, and firemen, both stationary and marine.

This instruction, without charge, has been arranged in the belief that it will reduce fuel consumption, insure efficiency in the handling of oil-burning equipment and lower operation costs. It is aimed to make the course as practical as possible, with sufficient theory to make it interesting.

The course began Aug. 1, 1923, with a class of twelve men. Up to the present time 350 men have applied, of whom 325 have completed the course satisfactorily and have received their certificates. New students may enter at any time.

The duration of the class is five days, Monday to Friday. The hours are 9 a.m. to 12 noon. The course is as follows:

Monday—Class enrolls. Introductory talk by instructor. Tour of inspection of plant. Lecture on oil burning. Description of Equipment.

Tuesday — Lecture on atomizers, steam, air, and mechanical. Oil-burning systems and burners. Lighting burners.

Wednesday—Lecture on combustion. Description and use of draft gage, CO_2 apparatus and stack thermometers. Demonstration in boiler room.

Thursday—Lecture on fuel oil and its properties. Laboratory demonstration of testing fuel oil for gravity, viscosity, flash point, burning point, water and sediment.

Friday—Lecture on care and operation. Review of course. Examination of student in boiler room.

"Mauretania" Turbines Reconditioned

Sixteen years of practically continuous service amply justifies the reliance placed in direct steam-turbine drive for the steamship "Mauretania." A minor trouble of one turbine occurred, which was described in the Dec. 5, 1922, issue of *Power*. At that time a noise developed in the starboard low-pressure turbine, and it was considered advisable to shut this down and lash the shaft driven by this unit for the remaining run to England.

The "Mauretania" is equipped with four shafts, the two outside ones being connected to high-pressure Parsons turbines, while each inner shaft is driven by a low-pressure turbine. For reversing and maneuvering, separate turbine elements are placed on the inner shafts, in addition to the low-pressure turbines.

When the casing was opened up on the turbine that gave trouble in 1922, several blades were found to be stripped and others distorted. The binding wires, in a number of cases, were found broken according to an account in the April 18, 1924, issue of *The Engineer* (London). The damaged rows of blading were then cut out and arrangements made for an entire overhauling at the end of the 1923 season.

On opening up the high-pressure units in the general overhauling, it was found that corrosion had been active through the high-pressure valves, strainers, rotors, and casings, ending at the last row of the first expansion blades of the high-pressure units. It was also ascertained that cast-iron valves, which in some instances had been substituted for steel, were practically unaffected.

Repairs included entirely new dummy packing casings for both high-pressure turbines, which are 7-ft. 10-in. bore. Packing strips were changed from those with axial clearance to the more modern type with radial clearance.

Machining the rotor for the fins of dummy packing was done aboard ship. On account of the lack of room, great ingenuity and patience were necessary in devising and utilizing tools for this work. The rotors and casings were not taken from their locations except to be raised or lowered as the work required.

A total of 132,960 blades were renewed out of 385,700 contained in the four units. Special attention was given to the binding wire in the low-pressure elements, which gave trouble on a previous occasion, as noted. On account of corrosion, the forward parts of both high-pressure turbines were machined. The new rotor surfaces were grooved for blading, and those of the stators for filling sleeves.

The work will probably be completed so as to place the ship in service by June, 1924. The best previous speed record is 26.06 knots for the average of a single trip in September, 1910. It is expected that this record will be broken.

St. Lawrence Commission Will Start June 13

THE St. Lawrence Commission, of which Commerce Secretary Hoover is head, and the Board of Engineers, of which General Jadwin is chairman, expect to make a trip down the St. Lawrence as far as Montreal, with the idea of visualizing the situation which they have been called upon to consider. It is probable that the Canadian members of the Board of Engineers also will make the trip, but so far as has been learned, the members of the Canadian National Commission are not planning to go. The party will assemble at Niagara Falls, Ontario, June 13, and will visit the Welland Canal and some of the operations of the Ontario Hydro Commission. They will then proceed down the lake to Kingston and transfer to the St. Lawrence boat. Further inspections will be made in the Cornwall region, from which point the remainder of the journey to Montreal will be made by automobile.

Coal Wholesalers To Study Oil Competition

Competition of oil with coal will be one of the subjects for discussion at the annual convention of the American Wholesale Coal Association, at White Sulphur Springs, W. Va., June 3 and 4. Among the phases of the subject that will be discussed are the following: To what extent has oil displaced coal? What further inroads may be expected? Is the competition substantial and permanent or is it merely temporary and passing? Is oil an economical fuel? Is the supply regular and dependable?

It is felt that this discussion will bring out the relative values and costs of the fuels in question, together with the outlook for regular and continuous supply of each for the future.

Another California Petition for Water-Power Act

A petition bearing over 38,000 signatures to place the water and power act on the November, 1924, California State ballot has been filed with the registrar of voters of the County of San Francisco. The petition contains more than half of the 73,000 signatures necessary for the entire state to insure the measure being placed before the people. The new act is practically identical with the one that was defeated in 1922. The act aims to give the people of California full control of the water and power resources of the state eventually.

A board of five appointed by the Governor, would have at its disposal half a billion dollars for developing and distributing water and electrical energy and acquiring any property necessary therefor. It would also give the state and political subdivisions certain preferential rights as against privately owned public utilities selling water or electrical energy.

Merrill Endorses Bill for Gathering of Data on Water-Power Resources

Senator Ransdell Introduces Bill—Water-Power Resources Not Known, Says Merrill

IN INTRODUCING a bill providing for the gathering of information necessary to a comprehensive plan for the development of the water resources of the United States "for the purpose of providing electric power for farms, rural communities, cities and industries," Senator Ransdell of Louisiana had printed in the *Congressional Record* the following indorsement of his bill by O. C. Merrill, the executive secretary of the Federal Power Commission:

"Of all our major national resources we know less about our water-power resources than any other. We have made extensive examinations of our coal, oil, and gas fields, have plotted their location and have estimated the total resources available. We have done similarly with respect to other of our important mineral resources. We have made a fairly careful estimate of our total timber resources, both those upon public lands and those upon private lands, and we can predict fairly closely the extent to which we can use these resources if we are to maintain a continuous supply. With respect to our water resources, the Geological Survey has maintained for many years a series of gauging stations upon our rivers. The records there taken make it possible to estimate the total water supply available at these stations with much the same degree of accuracy as apply to our estimates of minerals and timber, but an estimate of the amount of water flowing in a stream is but one of the factors required in order to know the extent of the power resources of that stream. To make reasonably satisfactory estimates of power we must know the drop in various sections of the stream where dams can be economically located, and in particular the possibilities of storage. On only a few streams in the United States have studies been carried to the point where reasonably complete information is available on which to draw the general plan of river development, not only for purposes of water power but for such other related uses as navigation, irrigation, public water supply, and flood control.

"The United States is now conducting on the upper Tennessee River the type of survey which we must have on other streams if we are to get adequate information for planning future development. This survey will cover an area along the river and its tributaries, will locate possible dam sites and particularly storage possibilities. The area of watersheds involved in these surveys is 31,000 square miles, approximately 1 per cent of the total area of the United States. This survey will have taken approximately four years to complete and at an estimated cost of $535,000.

"If surveys of similar scope are to be conducted on other streams of the United States, it is apparent that a considerable period of time and a considerable amount of money are involved. The item most likely to delay carrying out comprehensive surveys on the rivers and river systems of the United States is the question of finance, particularly at a time when endeavors are being made to reduce rather than to increase the scope of Federal expenditure.

"Section 4 of the Federal water power act authorizes the commission 'to make investigations and to collect and record data concerning the utilization of the water resources of any region to be developed, the water-power industry and its relation to other industries, and to interstate or foreign commerce, and concerning the location, capacity, development costs, and relation to market, of power sites.' That is, the commission has the authority to conduct adequate investigations on any stream of the United States where the question of water power is involved. The conduct of such surveys is therefore contemplated as one of the items in the administration of the Federal water power act.

"Section 10 (e) of the act provides that licensees shall pay to the United States 'reasonable annual charges in an amount to be fixed by the commission for the purpose of reimbursing the United States for the costs of the administration of the act.' It is apparent, therefore, that the funds so collected may be made available for the purpose of conducting surveys of the character described above.

"The Federal water power act provides for the collection of charges for reimbursing costs of administration in order that operation under the act shall be self-supporting and that the cost, but only the cost, of such operations shall be collected. If the charges which would be collected under rates prescribed by the commission are in excess of the costs of administration, the commission would be required under the provisions of the law to reduce its rates until the aggregate of charges collected corresponded to the total of expenditures. That point has now been reached with respect to its ordinary expenses of administration. Hereafter there will be funds available in excess of the requirements of ordinary administration to engage in surveys of water resources; and while the margin at the present time is not large, it is likely to equal $200,000 to $300,000 per annum within five years. Those who are paying charges under the Federal water power act will be willing to continue payment on the present schedule if the funds can be used for river surveys, because the information so secured would be of value to them. It is suggested, therefore, that provision be made, either by amendment to the Federal water power act or by a new bill such as that which you have in mind, to place these charges into a special fund in the Treasury, to be subject to use by the commission, not only for its ordinary purposes of administration but for these special surveys. In my opinion no better means is available for securing the necessary investigations and surveys, and they can be had without drawing in any degree upon the Treasury of the United States if the means which I have suggested be employed."

German Coal Mines Output Attains Pre-War Level

Nearly all the branches of the German coal industry have attained the pre-war level in output. Coke and bituminous coal are slightly under the pre-war figure, but production of lignite, upon which energy has been thrown since the Ruhr occupation, has increased more than 60 per cent.

The total production in March of bituminous coal, coke and lignite throughout Germany, exclusive of the Sarre Basin, was 26,000,000 tons against 22,600,000 for March, 1913.

A.I.E.E. Elects Officers for Next Year

At the annual business meeting on May 16, of the A.I.E.E. the following result of the election of officers was announced: President, Farley Osgood, Public Service Co., N. J.; vice-presidents, Harold B. Smith, Worcester, Mass.; L. F. Morehouse, N. Y.; Edward Bennett, Madison, Wis.; H. W. Eales, St. Louis, Mo.; John Harisberger, Seattle, Wash.; managers, John B. Whitehead, Baltimore, Md.; E. B. Merriam, Schenectady, N. Y.; J. M. Bryant, Austin, Tex.; treasurer, George A. Hamilton, Elizabeth, N. J. (re-elected). F. L. Hutchinson was reappointed secretary for the coming administrative year. These officers with the hold-over officers will constitute the Board of Directors.

Ford Granted Permit for Dam in Menominee River

Following a series of hearings before the Wisconsin Railroad Commission lasting over a period of several months, a permit has finally been granted to the Ford Motor Car Co., of Detroit for the construction and operation of a dam and power plant on the Menominee River three miles west of Iron Mountain, Mich., on the boundary line between Wisconsin and upper Michigan. This is one of a number of power sites that the company owns and proposes to develop in Wisconsin and Michigan in order to replace steam power with water power in its plants. It is estimated that an expenditure of $250,000 will be required.

According to plans submitted to the commission, three water turbines of 3,200 hp. capacity each will be installed in the power plant, which will be built across the river in Michigan, and will furnish energy to be used at the Ford woodworking plant to be established at Iron Mountain. The dam is to be 30 ft. high and 400 ft. long and will develop approximately 25,000,000 kw.-hr. a year according to data submitted to the commission.

New York Merchants Oppose Diversion of Lake Water

The Merchants' Association of New York, has recently adopted after a prolonged study, a report opposing the diversion of 10,000 sec.-ft. of Lake Michigan water for the Chicago Drainage Canal. A resolution founded upon this report which has been sent to Senators and Representatives from New York in Congress as well as to state and national executive officers is as follows:

"Resolved, That the Merchants' Association of New York is opposed to passage of the bills now in Congress and others which may be introduced which authorize the diversion of water from Lake Michigan through the Chicago Drainage Canal; in order that the several cases now before the United States Supreme Court, brought by the United States Department of Justice, the State of Wisconsin, the State of Michigan, and perhaps a case to be brought by the State of New York, may be tried by the Court and decided on their merits, unhampered by new legislation introduced in Congress since the filing of the cases.

"Resolved, That in order to protect the rights of the State of New York to unimpaired navigation of the Great Lakes and to undiminished flow of its boundary streams, namely the Niagara and St. Lawrence Rivers, and the power rights dependent thereon, this Association respectfully requests and urges the Attorney General of the State of New York to initiate and press litigation in opposition to illegal or unwarranted diversion of waters for the use of the Chicago Drainage Canal, as directed by a resolution of the State Legislature adopted April 9, 1924."

Opposition to Government Development of Great Falls Power Project

Col. Kelly Advocates Immediate Development by Private Interests—Tyler's Figures Considered too High

DISCUSSION of the development of the Potomac before the District of Columbia committee of the House has focused considerable Congressional attention on this project. The prevailing opinion apparently is that despite the proximity of Great Falls to the government's establishment in Washington, the development should be undertaken by private interests.

Opposition to governmental development also comes from those who oppose any increases in federal expenditures. They point out that private capital has given indications of its willingness to undertake this development. Even if there should be some delay on the part of private capital in taking hold of this project, they do not regard the need sufficient to embark the government on such an enterprise.

On the other hand, the testimony of Col. William Kelly, the chief engineer of the Federal Power Commission, indicates that this is a particularly propitious time to make this development. He thinks it should be done by private capital, however. He pointed out to the committee that the Chain Bridge development should be undertaken as early as possible so as to make unnecessary further investments in steam-plant extensions in Washington. He pointed out that a new steam unit just has been brought in by the Potomac Electric Power Co., which increases the capacity to the point where the steam plant probably could carry the increase in the load until the Chain Bridge power could be brought in. If the development is delayed, he calls attention to the fact that it then would be necessary to add more steam power, thereby saddling the whole proposition with additional investment, which would have to be carried.

Colonel Kelly in his second appearance before the committee emphasized again the unusual suitability of the Chain Bridge development as a peak power proposition. The pool which would be created there is large enough and the draw-down sufficient to be peculiarly adaptable to the handling of sudden peaks and would make possible the operation of the steam plant with a 100 per cent load factor. Colonel Kelly took exception to some of the figures submitted by the Potomac Electric Power Co. Were these figures correct, he contended, the steam plant at Washington would be much more efficient than any public-utility plant in New York or Philadelphia. If all costs are taken properly into account, he declared, he thinks the cost of steam power in Washington will be fully as much as in Philadelphia and New York and feels certain that Washington costs are in excess of nine mills.

One member of the committee, during the testimony of General Black, former Chief of Engineers, stated that he had been informed by a reliable engineer that the development of the Potomac as outlined in Major Tyler's report, would cost $75,000,000 instead of $45,000,000, as estimated by that officer. On being advised the name of the engineer who had made the estimate, General Black remarked that he is confident that it would cost that engineer $75,000,000 to construct the project. In view of the testimony that has been submitted during this hearing, there no longer is doubt that the project can be constructed at somewhat lower figures than those contained in Major Tyler's estimate.

Nevada-California Values Stand-By Plants

The value of a stand-by steam plant, from a dependable standpoint has just recently been proved by the experience of the Nevada-California Electric Corp., which usually depends on its hydraulic turbines for a great part of its power. In the early part of the year there was an unusual drought in California, and the Nevada-California company was forced to put on the line power generated from some steam plants that had been idle for a long period and also to buy current from other companies at rates higher than its selling contract figures, to meet its customers' demand.

The result was that while the operating earnings for the year ending March 31, 1924 were $416,000 above those of the corresponding period last year, expenses and taxes increased $559,000 resulting in a decline in surplus earned of $129,000.

Mechanical Engineer Wanted for Nitrogen Laboratory

The United States Civil Service announces an open non-assembled competitive examination for a mechanical engineer for high-pressure equipment to fill vacancy in the Fixed Nitrogen Laboratory, Department of Agriculture, at an entrance salary of $3,800. Eight years of experience in compressing and convoying equipment necessary. Apply to Civil Service, Washington, D. C., or post office in any city. Applications must be in by June 24.

Cumberland Plant Shut Down by Flood

The plant of the Potomac Edison Co. at Cumberland, Md., suffered a 48-hour shutdown during the floods of May 14-17. Water reached motor-driven auxiliaries, preventing plant operation, and power was then supplied to the city from other sources.

A transmission line to the station at Williamsport, Md., lacked a few miles of completion. Had this been connected, there would have been no interruption whatever of the service. The latter plant, which recently went into operation, is situated well above flood level.

National District Heating Program Announced

The National District Heating Association will hold its fifteenth annual convention at the Hotel Commodore, New York City, June 10-12. Papers on the program that will especially interest readers of *Power* are: "Report of Heating Research Committee," by H. T. Luscomb, chairman, New York City; "Steam Service Control," by William J. Baldwin, Jr., of the N. Y. Steam Corp.; "Report of Heat Utilization Committee," J. E. Seiter, chairman, Detroit, Mich.; "Report of Station Operating Committee," R. D. DeWolf, chairman, Rochester, N. Y.; "Estimating the Minimum Heating Requirements for Buildings," by A. C. Willard, University of Illinois; "Report of Corrosion Committee," by J. H. Walker, chairman, Detroit, Mich.

Water-Power Projects

Deep River Development.—Plans for the development of Deep River as a single power unit, somewhat in the manner that the Catawba River has been developed by the Southern Power

Co., are disclosed in a report made by the North Carolina Economic and Geological Survey. The plans contemplate utilizing the river for a space of 115 miles. This stretch has already on it a number of industrial plants, some using their own power, some buying it from other companies. It is declared that more than double the present amount of power could be obtained by linking up these interests, building reservoirs and conserving the water, and that periods of curtailment or reverting to steam power could be avoided. The fall included in the survey is 612 ft., of which 302 ft. has been developed.

Power Commission Will Set a Precedent.—The Federal Power Commission is expected to deny the application of Thomas Clark for a license covering a small development on the South Fork of the Merced River. The action on this project is important because it involves an important policy. The Clark development cannot make the same economic use of the stream's resources as would be the case in the larger conflicting application of the San Joaquin Light & Power Co. which contemplates a more comprehensive development of the river.

The Clark project is not such that a short-term license could be allowed, as was done in the case of the Excelsior Power & Light Co. on the Yuba River. In this latter case it was evident that the comprehensive development could not be carried forward for at least ten years, during which time the Excelsior company's plant could be amortized. In the case of the Clark proposal, however, the commission's engineers believe that power can be bought as cheaply as it can be developed along the lines he proposes.

Personal Mention

Henry A. Lardner, vice-president of the J. G. White Engineering Corp., New York City, was recently elected mayor of Montclair, New Jersey. Eighteen other candidates were in the field but he won, receiving the highest number of votes.

T. H. Burton, who has been associated with the crosstube boiler for many years, recently resumed relations with the Page Water Tube Boiler Co., of Chicago. This company is now building two types of water-tube boiler, one of cross-drum and the other of cross-tube construction.

Obituary

Frank C. Caldwell, a director of the Link-Belt Co., since the purchase of the H. W. Caldwell & Son Co. by the company in 1921, was stricken with heart failure the morning of May 15 while on his way to his bank. He died in an ambulance enroute to a hospital. Mr. Caldwell was born in Indianapolis in 1866 and went to Chicago in the early eighties to complete his education at Union College of Law. He practiced until 1892, when he became vice-president of the H. W. Caldwell & Son Co. He became president in 1908, continuing until 1921, and since then he had been a director of the Link-Belt Co.

Thomas Commerford Martin, for many years executive secretary of the N.E.L.A., died of pneumonia Saturday, May 17, at the House of Mercy Hospital, Pittsfield, Mass. While Mr. Martin's health had not been good for several years, his death came as a shock to his many friends and associates.

Besides his prominence in the N.E.L.A., he had, as editor of the *Electrical World* and other electrical papers for sixteen years, won distinction in the industry which grew from infancy to full vigor during the term of his editorship. Mr. Martin came to this country from England as a very young man and from 1877 to 1879 was associated with Thomas A. Edison in pioneer electrical work. He was past president of the A.I.E.E. and the Engineer's Club, and a member of the Institute of Electrical Engineers, (Great Britain), Illuminating Engineering Society, Society for Promoting Engineering Education, American Electrochemical Society and other scientific societies.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, June 11-13.

American Boiler Manufacturers' Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Annual meeting at the "Homestead," Hot Springs, Va. June 9-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 33 West 39th St., New York City. Annual convention, Edgewater Beach, Chicago, Ill., June 23-27.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44th St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 9-13.

American Society of Civil Engineers. J. H. Dunlap, 33 West 39th St., New York City. Convention, Pasadena, Calif., June 16-20.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Kansas City, Mo., June 10-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at Cleveland, Ohio, May 27-29.

American Society for Testing Materials. C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 23-28.

Canadian Association of Sationary Engineers. Gordon C. Keith, 51 Wellington St., West Toronto, Ont. Annual meeting, St. Thomas, Ont., June 24-26.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Illinois Association** at Rockford, Ill., June 4-6. L. G. Schlemm, 805½ South Ninth St., Springfield, Ill. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **New York State** at Niagara Falls, June 13-14. William Adelyotte, Shredded Wheat Co., Niagara Falls. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at Bridgeport. June 27-28. George F. Klopfer, 30 East Pearl St., New Haven, Conn. **New England States Association** at Cambridge, Mass., July 10-12. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Minnesota Association at Faribault,** Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22nd Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12.

Smoke Prevention Association. Frank A. Chambers, 111 North Dearborn St., Chicago, Ill. Eighteenth annual convention at Hotel Statler, Buffalo, N. Y., June 3-5.

Stoker Manufacturers Association. G. A. Sacchi, Westinghouse Elec. & Manufacturing Co., Philadelphia, Pa. Annual meeting at Edgewater Beach Hotel, Chicago, Ill., June 2-4.

Western Society of Engineers. E. S. Nethercut, 1736 Monadnock Bldg., Chicago, Ill. Meeting at Chicago, June 4, 1924.

Business Notes

The CoKal Stoker Corp., Chicago, Ill., has appointed the Kissick-Fenno Co., 53 Park Place, New York City, as its representative for the New York territory.

Colwell & McMullin, manufacturers of material-handling machinery, announce the removal of their offices from 79 Milk St. to the Park Square Bldg., Boston, Mass.

The Atlas Aluminate Cement Co., 25 Broadway, New York City, has been formed recently to acquire the Spackman patents and to manufacture high alumina cements, at Northampton, Pa.

The Connecticut Belting Co. of Norwich, Conn., has recently been organized. Its officers are: Ernest L. Baldwin, president and general manager; Francis H. Stager, vice-president; Stanley M. Kingsbury, treasurer.

The Buffalo Forge Co., Buffalo, N. Y., announces the opening on June 1, of a new Western office at Seattle, Wash. The territory of this office will also include Oregon, Idaho, Montana, Alaska and Washington. Arthur T. Forsyth, of the Buffalo plant, will be Western representative.

The Vacuum Ash and Soot Conveyor Co., Wilson Ave., Newark, N. J., announces the appointment of the H. G. Jarman Co., Farwell Bldg., Detroit, Mich., as its representative for the State of Michigan and the City of Buffalo, handling the sales and services of the Vasco suction and steam-jet conveyors.

The Crocker-Wheeler Co., manufacturer of electric motors, generators and transformers, Ampere, N. J., at its annual meeting elected Edmund Lang, president; Arthur L. Doremus, vice-president; Herbert C. Petty, secretary; Theodore S. Fuller, treasurer; George W. Bower, assistant secretary and treasurer.

Trade Catalogs

Cranes—Herbert Morris, Inc., Buffalo, N. Y. Book 5060 "Thrift in Lifting," is a compact little book about overhead cranes of standard type made by the Morris company.

Starters—Allen-Bradley Co. Milwaukee, Wis. Leaflet describing Type J-1552 across-the-line starting switch, Type H-1852 semi-automatic resistance starter and Type J-3052 automatic resistance starter.

Lubrication Data — Waverly Oil Works Co., Pittsburgh, Pa., U. S. A. Pamphlet "Industrial Lubrication," gives useful charts for lubrication of power plant machinery as well as industrial machinery.

Compressors, Centrifugal—De Laval Steam Turbine Co., Trenton, N. J. Catalog F, is about centrifugal blowers and compressors for water-gas plants, coke-oven plants and general industrial services. It gives besides the descriptive matter, illustrations and general information, a chapter on compression of gases.

Illuminometer, Macbeth—Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin No. 680, which is reprinted from the 1920 edition, contains full descriptions as well as directions for operating this meter for measuring intensity of illumination.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	May 17, 1924	May 19, 1924
Pool 1	New York	$3.00	$3.00
Smokeless	Columbus	2.35	2.35
Clearfield	Boston	2.35	2.40
Somerset	Boston	2.50	2.50
Kanawha	Columbus	...	...
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.95	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.85	1.85
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—May 22, light oil, tank-car lots, 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—May 13, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.60@$1.65 per bbl.; 28@30 deg., $1.65@$1.70 per bbl.; 32@36 deg., gas oil, 5¼c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—May 13, f.o.b. local refinery, 30@34 deg., fuel oil, 5⅝c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.; 34 deg., neutral, 8¼c. per gal.

Dallas—May 16 f.o.b. local refinery, 26@30 deg., $1.30@$1.35 per bbl.

Philadelphia—May 16, 28@30 deg., $2.31@$2.373 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.785@$1.848 per bbl.

Boston—May 6, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅝c. per gal., light oil, 28@32 deg., Baumé, 6⅝c. per gal.

Cincinnati—May 19, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 6c. per gal.

New Plant Construction

Ala., Cherokee—The Cherokee Rock Asphalt Co. plans for a boiler plant at its proposed works on tract of sandstone rock asphalt lands. The entire project is to cost close to $250,000. Dr. Miller Reese Hutchison, 233 Broadway, New York, is said to be interested in the project.

Ala., Florence—Bonds have been voted for $100,000 for extensions, and improvements in municipal waterworks and system, including pumping equipment. The Board of City Commissioners is in charge.

Calif., Arvin—The Standard Oil Co. of California, Bakersfield, plans for a pumping station at its proposed storage and distributing plant.

Calif., Bakersfield — The San Joaquin Cotton Oil Co., recently organized, plans for a boiler plant at its proposed cottonseed oil mill, to cost $70,000. Stanley R. Pratt, president and general manager.

Calif., Fresno—The People' Ice Co. will begin erection of an addition to its ice-manufacturing plant at 2035 South Broadway, to cost $42,000, which will increase the present output by 250 tons every 24 hours. A general building contract awarded to Russell Hess, Fresno.

Calif., Hanford—The Krismo Fruit Co., is said to be considering plans for an ice and cold storage plant for its proposed packing house. The project to cost about $75,000.

Calif., Los Angeles—The Columbia Cement Co., Los Angeles, Fred A. Ballin, president, plans for a steam electric power plant at its proposed cement mill on site near Dixie, Imperial County, to cost $900,000.

Calif., Los Angeles—The Petroleum Export Corp., Pacific Electric Bldg., plans for a pumping plant at its proposed oil storage and distributing works at Terminal Island, San Pedro Harbor, to cost $2,500,000. G. A. Smith is vice-president.

Calif., Merced — The Merced Irrigation District, Bancroft Bldg., will take bids until May 31, for the construction of its proposed Exchequer dam and power house on the Merced River, Mariposa County, as epr plans and specifications at the office of H. P. Sargent, secretary. R. V. Meikle is chief engineer, and A. J. Wiley, consulting engineer. The power dam and reservoir is estimated to cost $4,569,258; and the power station, $1,321,701.

Calif., Newport Beach — The Board of City Trustees plans for a pumping station in connection with a proposed water system at Corona del Mar, to cost $50,000. Paul E. Kressly, H. W. Hellman Bldg., Los Angeles, engineeer.

Calif., Oxnard—The Ord Ice Co., Santa Barbara, is planning for an ice-manufacturing plant, to cost $100,000, with equipment.

Calif., Santa Barbara—The City Council is having plans drawn for the enlargement in the sewerage system. Bonds for $407,000, recently were voted. The work will include a screen plant, with motors, valves, gates and appliances; new pumping station, with installation consisting of two 12-in. centrifugal pumps, direct-connected to motors, with piping, valves, etc., all as per specifications on file at the office noted. Herbert C. Nunn is city manager.

Calif., Santa Barbara—The Santa Ynez Valley Irrigation District, Edward De La Cuesta, Buellton, Calif., head, plans for a series of electric-operated pumping plants in connection with an irrigation project to provide for 100,000 acres. J. J. McGregor, engineer for the Union Sugar Co., is interested in the enterprise.

Calif., Ventura—The Southern Counties Gas Co. will install additional compressor equipment at its plant, increasing the capacity from 150 to 350 lb.

Conn., Middletown — The Standard Oil Co. of New York, 26 Broadway, New York, plans for a pumping plant at its proposed oil storage and distributing plant on the River Road, to cost $850,000. Plans have been completed. C. A. Ellis, chief engineer.

Conn., New Haven—The New Haven Saw Mill Co. will begin work converting its plant from steam to electric operation, with the installation of motors, controls and other equipment.

D. C., Washington—The Bureau of Accounts and Supplies, Navy Department, will receive bids until June 3, for 242,300 lb. boiler compound, as per Schedule 2185, for use at various yards.

D. C., Washington—The general purchasing officer, Panama Canal, will receive bids until June 5, for centrifugal pump, presure gages, grease cups, belting, firebrick, lubricating and cutting oils, and other material as specified in Circular 1611. Also, at the same time for 45,000 lb. cup grease, 10,000 lb. lubricant, 15,000 gal. mineral oil, 10,000 gal. car and locomotive engine oil, 200,000 lb. colored cotton waste, and 25,000 lb. white cotton waste, as per Circular 1609.

Fla., Haines City—Bonds for $265,000 have been approved for a municipal electric plant, waterworks extensions and other municipal improvements.

Fla., Kissimmee—The Sugar Belt Citrus Growers Association, recently organized, plans for an ice and cold storage plant at its proposed fruit packing house. Plans will soon be drawn. W. E. Frank, Narcoossee, Fla., president.

Fla., Melbourne—The Common Council contemplates electric-operated pumping equipment in connection with extensions and improvements in water and sewerage systems. Bonds for $155,000 are being arranged for these and other municipal work.

Fla., Winter Haven—The Lake Marion Groves Corp., recently organized, is said to be planning for a pumping plant in connection with water system on land on Lake Marion for residential service. A. D. Newkirk, Winter Haven, consulting engineer. H. W. Snell, president.

Ga., Barnesville—A bond issue of $30,000 has been approved to be used for waterworks and sewerage extensions, including pumping equipment. Plans will be drawn and bids asked soon.

Ga., Stillmore—W. J. Morgan, R. F. D. No. 3, is in the market for boiler and pumping equipment for a turpentine works.

Idaho, Shoshone—The Common Council has tentative plans for municipal electric plant, and will secure estimates of cost at once.

Ill., Springfield—A boiler plant will be installed in the eleven-story hotel to be erected on local site by a company now being organized by H. B. Hill, and associates, to be known as the Hotel Abraham Lincoln, estimated to cost $1,500,000. Helme & Helme, First National Bank Bldg., architects. J. Clyde Evans, 509 South Sixth St., has general contract for building.

La., Baton Rouge — The Mengel Co., Louisville, Ky., manufacturer of boxes, etc., plans for a central steam power plant at its proposed mill for manufacture of automobile wheels and kindred products. Construction to begin at an early date. The entire project will cost $1,000,000.

La., Plaquemine—The A. H. R. Lumber Co., recently organized, plans for a boiler plant at its mill. R. O. Allen, president.

La., Shreveport—In connection with reorganization plans, the Caddo Central Oil & Refining Corp. is developing a fund of $500,000, to be used for modernizing its gasoline refining plants, to include air compressors, pumping equipment and other power apparatus. Eastern offices of the company, 61 Broadway, New York.

Md., Baltimore—The Board of Directors, Maryland Penitentiary, plans for the reconstruction of the steam power plant at the institution with additional equipment. An appropriation of $150,000 is available for this and other work. Claude B. Sweezey, warden in charge.

Md., Leonardtown—The Common Council plans for a pumping plant for the proposed municipal water system. A bond issue of $40,000, has been approved. Stephen M. Jones is commissioner in charge.

Mich., Detroit—The Public Lighting Commission is reported to have tentative plans for a new power plant of 50,000 kw. It is expected to begin work in the fall.

Mich., Jackson—The Taylor Produce Co., Kalamazoo, Mich., is considering extensions in the ice and refrigerating plant at the factory of the Jackson Farm Produce Co., recently acquired, including additional machinery.

Minn., St. Paul—The Board of Trustees, Macalester College, plans to take bids early in June for the construction of the power house at the institution, to cost $50,000. William W. Ingeman, Endicott Bldg., is architect.

Miss., Ariton—The National Lumber Co. recently organized is reported to be planning for a boiler plant at its proposed mill. O. S. Ranier, president.

Miss., Biloxi—The Biloxi Artesian Ice Mfg. Co., plans buying horizontal return tubular boilers, from 150 to 200 hp. capacity; feed-water heaters and accessory apparatus, for its plant.

Miss., Hazlehurst—The L. H. Yarborough Lumber Co. is reported to be planning for a boiler plant at its proposed new mill.

Miss., Jackson—The Enochs Lumber & Mfg. Co., plans for a boiler plant at its proposed mill, to replace a works recently burned. Work to begin at an early date. The Flagler Co., Atlanta, Ga., has general contract for buildings.

Miss., Tupelo—The Mississippi Power & Light Co., Jackson, has acquired the electric power plant of the Tupelo Cotton Mills, and plans to develop for central station service. Steam and electric power service will be continued at the cotton mills.

Mo., Caruthersville—The Arkansas-Missouri Power Co. recently acquired by A. E. Fitkin & Co., 165 Broadway, New York, has asked permission to issue bonds for $684,000, a portion to be used for extensions in power plants and system.

Mo., Bolivar—The Tri-Cities Power Co. has acquired the municipal power plant, and plans to extend and improve for central station service.

Mo., Kansas City—The Interstate Refinery Co. is reported to be planning for the installation of steam power equipment and pumping apparatus in connection with rebuilding of its oil refining plant, recently partially burned with loss of $150,000.

Mo., Perryville—The Perry County Ice, Electric Light & Power Co., recently organized, is said to be planning for an ice-manufacturing plant. Felix B. Holcomb is head.

N. J., Bridgeton—The Board of Trustees, Bridgeton Hospital Association, plans for a steam power plant at its proposed hospital. Entire project to cost $400,000. Stearns & Woodnutt, Stephen Girard Bldg., Philadelphia, Pa., architects.

N. J., Ridgefield—The Lowe Paper Co., River St., is considering a boiler plant in connection with several new mill buildings, to cost $150,000. A general contract has been let to the H. Wales Lines, State St., Meriden, Conn.

N. Y., Brooklyn—The Rubel Ice & Coal Corp., 197 Glenmore Ave., is having plans completed for an ice-manufacturing plant, at Ozone Park, to cost $80,000. E. M. Adelsohn, 1778 Pitkin St., Brooklyn, architect.

N. Y., New York—The Palestine Development Council, Inc., 15 William St., has information regarding a proposed hydro-electric power plant to be constructed on the Jordan River, Palestine, for light and power service, with cost reported at $500,000.

New Zealand, Wellington—The Secretary, Public Works Supplies and Tenders Committee, will receive bids until July 29, for turbines and generators for the Lake Coleridge power plant. Also, at the same time, for riveted and welded pipe for the station, all as per specifications on file at the office noted.

N. C., Asheville—The City Commissioners have plans for an electric power plant for light and power at a tourist camp to be developed. Frank L. Conder is commissioner of public works.

N. C., High Point—A bond issue of $709,000 is being sold, of which $200,000 will be used for extensions and improvements in waterworks, with pumping equipment; $299,000 for similar work in connection with sewerage system; and $30,000 for municipal electric light work.

N. C., New Bern—Allie Cook, New Bern, and associates, are planning for a refrigerating plant in a proposed meat-packing works, and will make inquiries for data and prices soon.

N. C., Swannanoa—The Beacon Mfg. Co., New Bedford, Mass., plans for a power house at its proposed cotton mill. Plans have been prepared by Knight C. Richmond, Providence, R. I., engineer. The entire project will involve $450,000. A contract for a number of buildings has been awarded to Morton C. Tuttle Co., Boston, Mass.

N. C., Winston-Salem—The Board of Aldermen has approved a bond issue of $750,000 for extensions, improvements and additional pumping equipment in the waterworks and system. Plans will be prepared soon.

Ohio, Osborn—The Southwestern Portland Cement Co., El Paso, Tex., has decided definitely to construct a cement mill, and will have plans prepared at once. A steam power plant will be installed. The project will involve $2,000,000. O. J. Binford, secretary, will reside at Dayton, Ohio, and be in active charge of the work.

Okla., Grove—The Public Service Co. of Oklahoma, East Fourth St., Tulsa, has applied to the Federal Power Commission for preliminary permit for a proposed hydro-electric generating plant on the Grand River, near Grove, with initial capacity of 10,000 hp., to cost in excess of $750,000. The company is operated by the Byllesby Engineering Co., 208 South La Salle St., Chicago, Il.

Ore., La Grande—A bond issue of $30,000 for a municipal waterworks and pumping plant, has been defeated at a special election. Project will be held in temporary abeyance.

Ore., Marshfield—The Board of City Trustees plans for a pumping station in connection with extensions in the water system. A bond issue of $225,000, has been sold.

Pa., Colwyn—The G. Woolford Wood Tank Mfg. Co., Lincoln Bldg., Philadelphia, Pa., plans for a steam power plant at its factory, and will begin work soon.

Pa., Darlington—The Alliance Brick Co. plans for a boiler plant at its new brick-manufacturing yard on the Darlington-East Palestine Highway. Erection of the buildings will begin soon.

Pa., Delta—The Susquehanna Water Power Co. has applied to the State Waters and Power Resources Board, Harrisburg, for permission to change the channel of the Susquehanna River in connection with its proposed hydro-electric power plant on the stream, on site near Conowingo, Md.

Pa., Grove City—The City Council has awarded a contract to the Bessemer Gas Engine Co., with local plant, for three 350-hp. Diesel engines for its municipal electric power station, now in course of construction, and will place orders for other equipment and materials at an early date. Station ready for service in the fall.

Pa., Harrisburg—Bids are being asked until June 10 by the Department of Property and Supplies, Berkey H. Boyd, secretary, Capitol Bldg., for an addition to the power plant at the State House, to consist of boilers, steam-electric generator and accessory apparatus of 800-kw. capacity, supplementing the 600-kw. station now installed. An appropriation of $150,000 is said to be available. Also for a refrigerating system for drinking water service; all as per plans and specifications on file. Arnold W. Brunner, 101 Park Ave., New York, architect.

Pa., Philadelphia—The Board of Trustees, Drexel Institute of Art, Science and Industry, Thirty-second and Chestnut Sts., is arranging for additional endowment of $1,000,000, a portion for steam power equipment for the steam engineering course at the institution.

Pa., Pittsburgh—The Allegheny Steam Heating Co., 435 Sixth Ave., operated by the Equitable Gas Co., plans to begin a new boiler plant, to cost $80,000, with equipment.

Pa., Pittsburgh—The United States Engineer will take bids until June 11, for two hydro-electric generating plants for Locks 7 and 8, Monongahela River, as per plans and specifications on file.

R. I., Pawtucket—The Blackstone Valley Gas & Electric Co. has sold a note issue of $2,700,000, and will also sell a stock issue of $1,300,000, a portion to be used for its expansion and improvement program in generating plants and system during the present year, involving $3,500,000. The company is operated by Stone & Webster, Inc., 147 Milk St., Boston, Mass.

S. C. Inman—The Water and Sewer Commissioners will take bids until May 30, for equipment for a waterworks and sewerage system, including two 750 g.p.m. centrifugal pumps; two deep-well pumps one 75,000 gal. tank and tower, and accessory apparatus. The Ryan Engineering Co., Arcade Bldg., Columbia, S. C., engineer, J. P. Parker, town clerk.

S. C., York—The Common Council contemplates a pumping plant in connection with extensions and improvements in waterworks and sewerage systems. A bond issue of $35,000, is being arranged.

S. D., Hot Springs—The Board of Managers of the State Soldiers' Home, will take bids until July 8, for power equipment, including one engine and generator, about 70-hp. capacity, with switchboard and accessory equipment, as per plans and specifications on file at the office noted, or that of the State Engineer, Pierre, S. D.

Sweden, Stockholm—The Waterfalls Administration, Stockholm, plans for a hydro-electric plant on site purchased by the Government on the Umeaa River, Northern Sweden, for which an appropriation of $1,600,000, is being arranged. The American-Swedish News Exchange, 52 Vanderbilt Ave., New York, has information on the project.

Tenn., Athens—C. L. Williams, Athens, plans for an ice and refrigerating plant at his proposed meat-packing house on Athens-Etowah Highway, to cost about $75,000. It is purposed to organize a company to operate the plant.

Tenn., Union City—The Board of Aldermen will take bids until June 18, for equipment for waterworks and sewerage system, including pumping equipment, air compressor, feed water-heater, steam superheaters and other accessory apparatus. W. D. Keiser is city recorder.

Tex., Fort Worth—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until June 3, for two nitrogen compressors, for use at the naval property, as per Schedule 2204.

Tex., Fort Worth—The McCorkle Pipe Line Co., 504 Burnett Bldg., S. S. McCorkle, chairman of the board, plans for a series of electric-operated pumping plants in connection with a 435-mile pipe line, and will place contracts for equipment soon.

Tex., Houston—The Southern Construction & Mill Supply Co. plans buying a 1,200-hp. Corliss engine, with boiler units to an aggregate capacity of 1,500 hp., and accessory equipment.

Tex., Plainview—The Plainview Compress & Warehouse Co., recently organized, contemplates a boiler plant at its proposed cotton compressing works. Plans are under way. A. S. Underwood, president.

Tex., Ralls—Bonds for $50,000 have been approved, for a municipal waterworks and pumping station. Plans will soon be prepared. The Common Council, John Haney, mayor, is in charge.

Va., Oulaski—M. R. Schottland, Martinsville, Va. will build a steam electric power plant with capacity of 350-kva. at his proposed furniture factory. The entire project will cost $150,000. Equipment for the power plant will be purchased soon.

Va., University (P. O. Charlottesville)—The Board of Directors, University of Virginia, will install a cold storage plant, ice-manufacturing plant and mechanical laundry in a new building to be erected at the institution. Work will be commenced soon. Dr. J. A. Hornsby, superintendent at the University of Virginia Hospital, in charge.

Va., Winchester—The C. L. Robinson Ice & Cold Storage Co. has awarded a general contract to the Quigley-Hafer Co., Chambersburg, Pa., for an ice-manufacturing and refrigerating plant, to cost $100,000. Machinery costing $65,000 will be installed.

Wash., Seattle—The Seaman Paper Co., 208 South La Salle St., Chicago, Ill., plans for a boiler plant at its proposed paper mill. The entire project will involve $1,500,000.

Wash., Yakima—The Yakima County Horticultural Union has filed plans for a new ice and cold storage plant on A Street, near Railroad St., to cost $75,000.

W. Va., Fairmont—The Hutchinson Coal Co. has tentative plans for steam power plant at Erie Mine, to replace one recently destroyed by fire. An official estimate of loss has not been announced.